MARCH 1969 50 CENTS

Popular Science

MONTHLY

What the Apollo 8 Moon Flight Really Did for Us
By WERNHER VON BRAUN

hat Close Calls o to Your Driving

ow: Canned Movies n Your TV Set

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- Condon Report on UFOs: Is It Fact or Phony?
- Can We Stop Earthquakes from Happening?
- A Laser You Can Buy for Under $100
- All About the New Polaroid Cameras
- Radial Engine Powers Pontiac's Mini-Car
- Top-of-the-Line Garden Tractors
- How to Choose and Use a Canoe
- Rocks in My Head: PS Reporter Bob Gannon takes a firsthand look at the perils and pleasures of rock climbing
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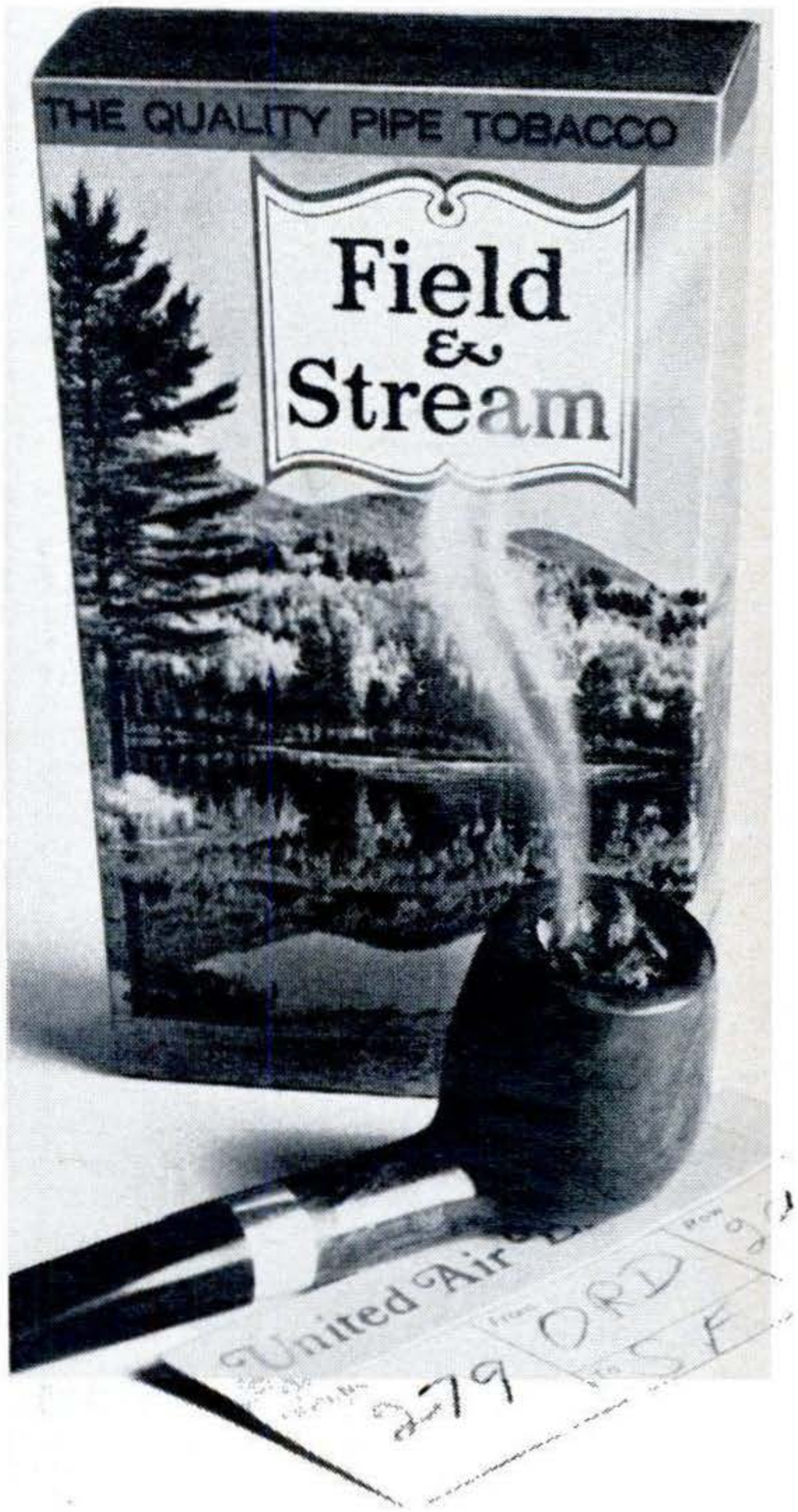
If your wife says she doesn't go for the great autumn day aroma of Field & Stream...



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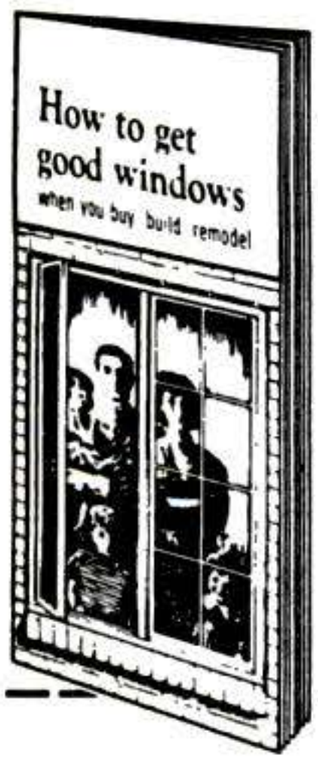

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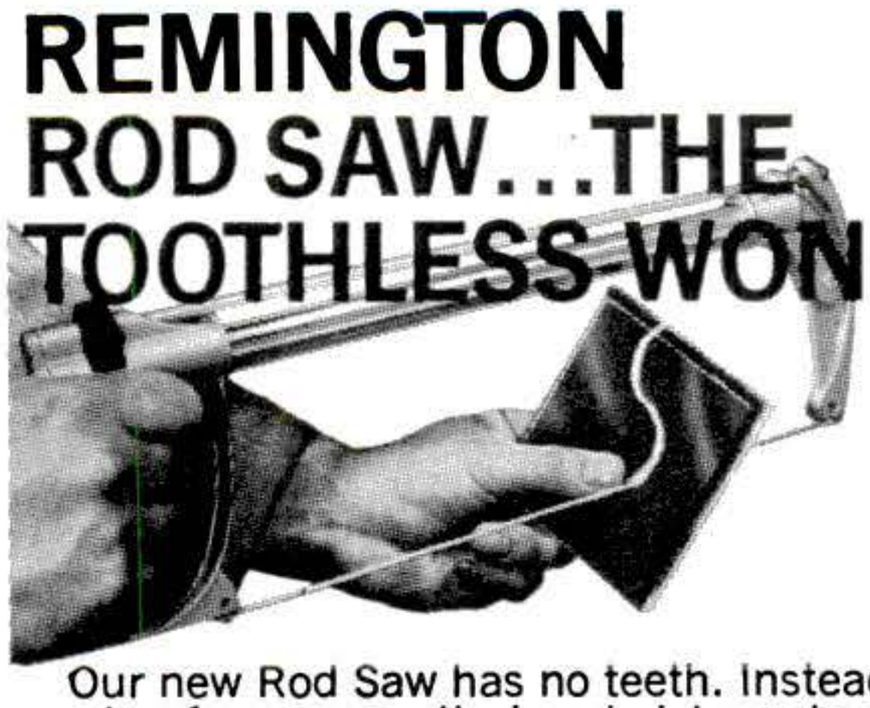

Our new Rod Saw has no teeth. Instead, it has thousands of permanently bonded tungsten carbide cutting edges.

The rod itself fits any standard 10" hack saw frame But the similarity ends there. Because the Rod Saw cuts through things a regular hack saw blade won't even scratch.

It cuts through spring steel, hardened bolts, welds and cast iron with ease. And because of the tool design, the cutting edges go all the way around the rod. So it not only cuts straight, but also cuts in any direction on brick, glass, flagstone, ceramics, fiber glass, laminates and other hard-to-cut materials. (And does it faster, because it cuts on both forward and backward strokes).

Originally developed for industry, now priced for home use, the Remington Rod Saw is now available at most hardware stores.

You should not have any trouble recognizing it. Just look for the saw without any teeth.

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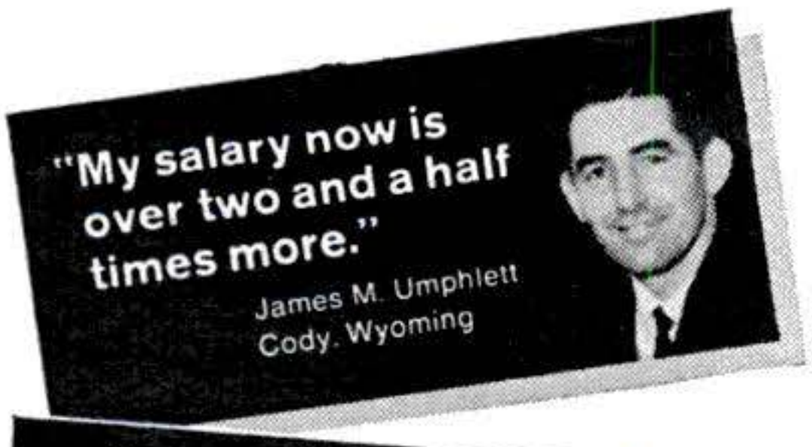

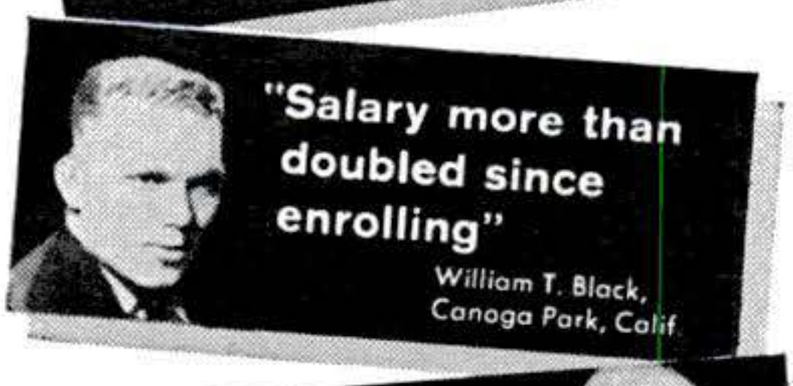

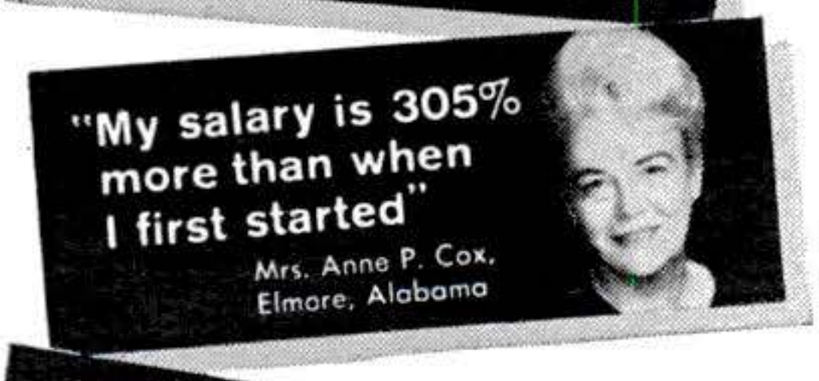

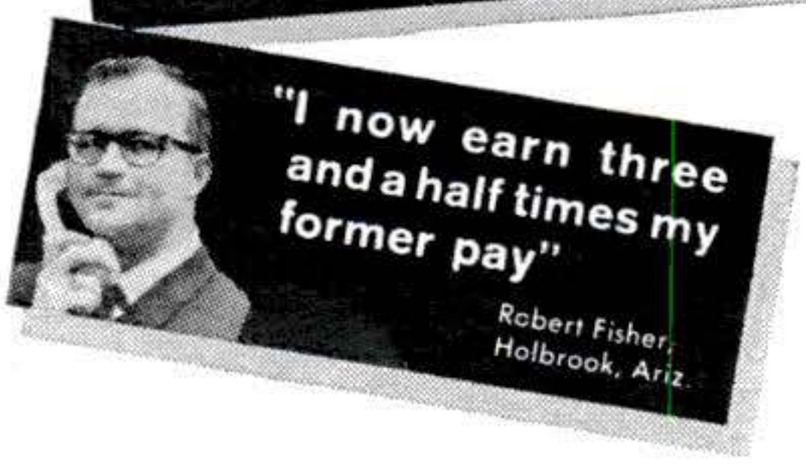

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Print Name.....Age.....

Address.....Apt. No.....

City.....

State.....Zip No.....

EDUCATION: *(Fill in number of years completed)*

Grammar School.....years
High School.....years
College.....years
Other.....years

PRESENT EMPLOYMENT:

Kind of position.....

Hours of work.....A.M. to.....P.M.

GENERAL INFORMATION:

☐ Single ☐ Married

Estimated spare hours per week available for study .....

343

ACCOUNTING
- ☐ Complete Accounting
- ☐ Income Tax
- ☐ Accounting Fundamentals
- ☐ CPA Training
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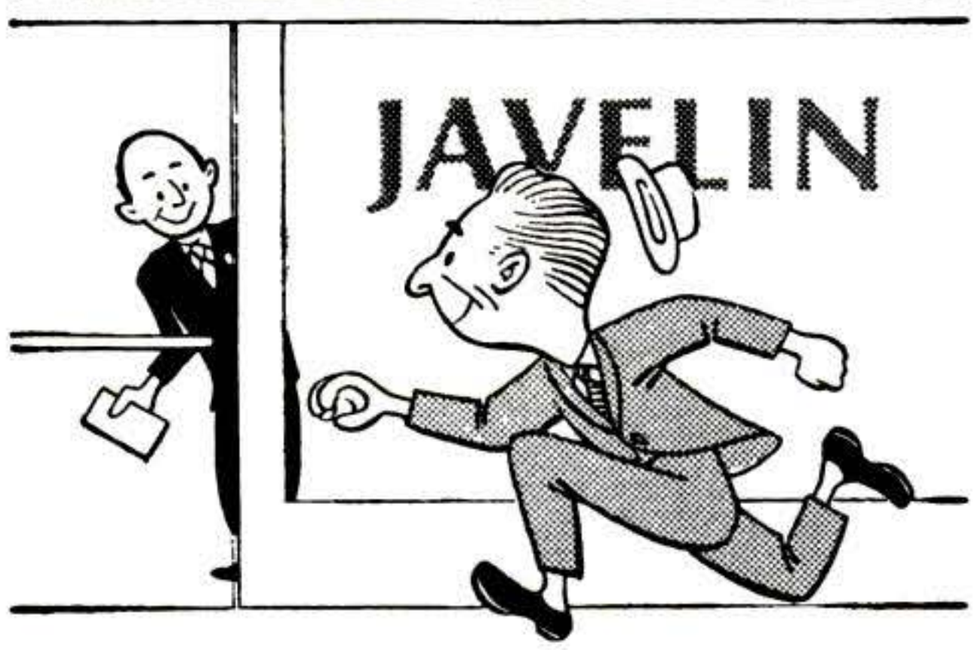
PS Readers Talk Back

A sporty choice

I read with great interest "Just How Sporty Are This Year's Sporty Cars?" [Jan.]. The Norbye/Dunne Report on the Camaro, Cougar, Mustang, and Firebird



helped me make my decision. I used the report as a foundation and now I know for sure which car to buy. I'll take the Javelin.

TED BENOIT, Cohoes, N.Y.

. . . How can Norbye and Dunne consider their test complete without including the Plymouth Barracuda and the AMC Javelin? Are they afraid that their over-rated Firebird would be shown up?

S. A. ROSENTHAL, Inglewood, Calif.

The Barracuda and Javelin were not included in the test because they are virtually unchanged since last year. The Norbye/Dunne Report covering those two cars [Feb. '68] can be consulted for comparison with cars tested this year.

. . . What kind of country road did Norbye and Dunne have in mind for the Firebird? The Firebird's ground clearance is only 3.8 inches. Sitting this low to the ground on Arizona country roads would be suicide. I've been on roads strewn with rocks at least four inches in diameter. They could make quite a mess of the fuel tank and muffler if they were hit. Running out of gas out on an Arizona country road would not be too pleasant.

TYLER M. OLSON, Phoenix, Ariz.

Two views on the Bomb

Thanks for Fletcher Knebel's "Can Atomic Scientists Ban the Bomb?" [Dec. '68]. I think the average citizen (most PS readers) is tired of listening to the brass hats who are too fat to care about the taxes we pay and too fat-headed to see that the arms race is getting us precisely nowhere.

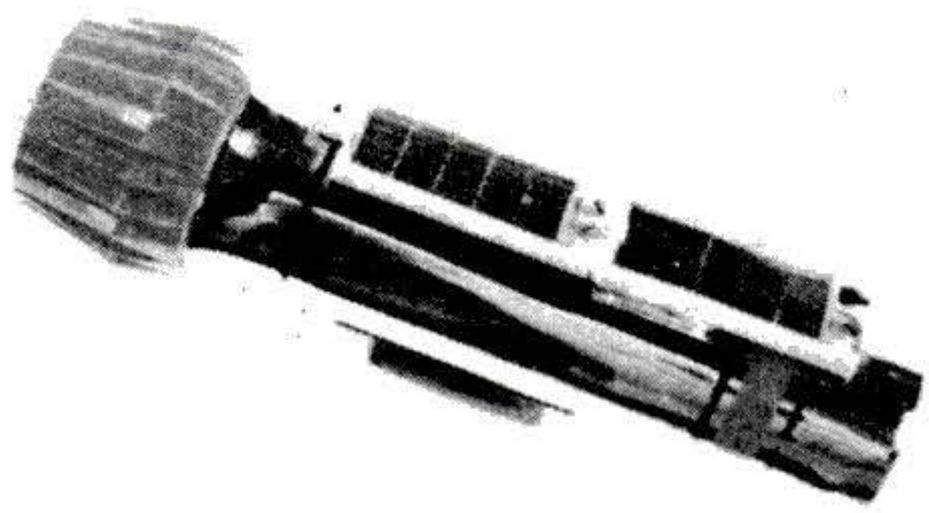
HARRY JOHNSON, Santa Fe, N.M.

. . . It would be just peachy if the nuclear problem would go away, but wishful thinking remains wishful thinking. I find extremely irritating the assumption that scientists, simply by virtue of being scientists, are magically invested with super-insight into world political problems. A nuclear physicist per se has no more competence in the area of international affairs than a Secretary of State has in nuclear physics. Why must the "politician" be made the fall guy for human failings? After all, it's the politicians who have been working hard (and successfully) for the past 25 years to prevent the use of the weapons turned out by the physicists.

BARRY T. CRICKNER, Falls Church, Va.

Builds a solar-powered flashlight

Your fine magazine has been a principal contributor to my scientific education for the past 35 years. As a NASA research scientist, I often gave talks to visitors, for which I built gadgets to demonstrate with. One of these is a solar-cell flashlight like that Paul Magno asked for in "I'd Like to See Them Make" [Jan.]. It will soon be offered by a firm I recently founded. The one below has



worked for six years. It has nickel-cadmium rechargeable D cells and a series-charging diode.

DR. JOHN C. EVANS JR., N. Olmstead, Ohio.

Another view of contact lenses

We believe that a number of statements in "Contact Lenses Anyone Can Wear" [Jan.] are erroneous and might be incorrectly attributed to Bausch & Lomb.

The article says that everyone can wear the new hydrophilic contact lenses. This is neither claimed nor true. It also reports that the lenses can be worn continuously, which also is not true. Hours of wear should be decided by an eye-care practitioner. The lenses do not correct any significant amount of astigmatism; nor do they retard myopia,

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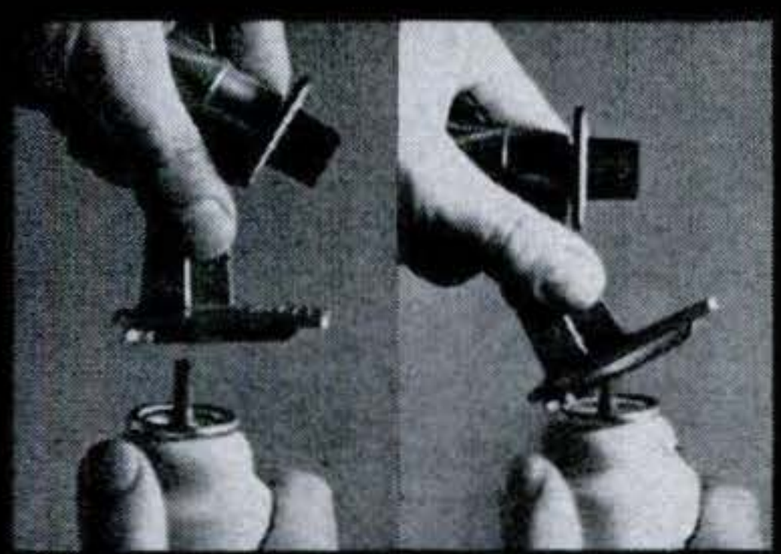
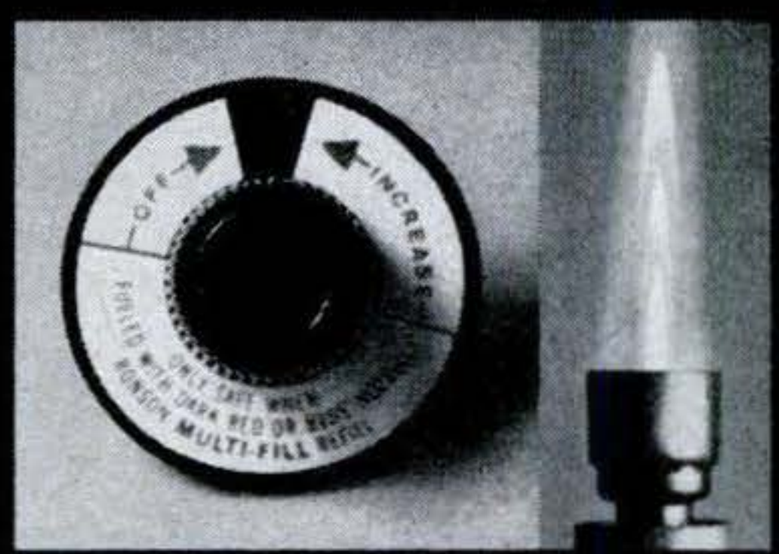


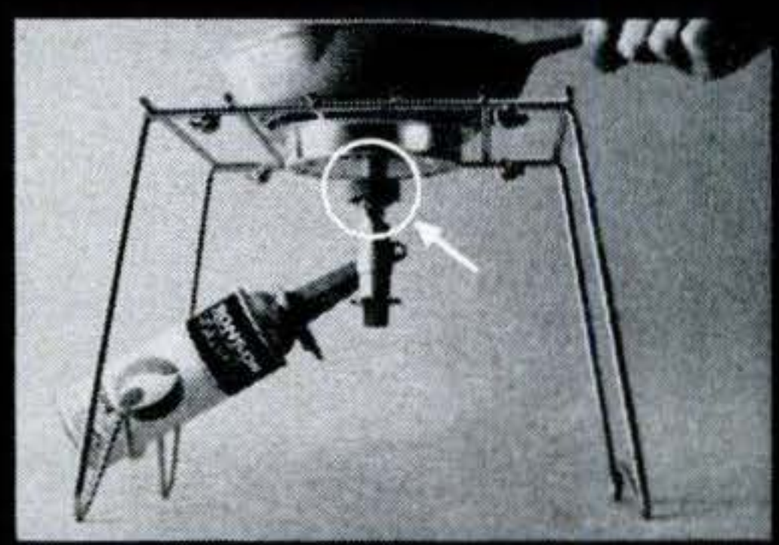
A SNAP TO FUEL: Place Ronson Varaflame® Torch in position over Ronson butane Multi-Fill® fuel injector and SNAP...you're set for hours of hobby-making fun, or serious professional work.



DIAL YOUR FLAME: Turn calibrated dial, to precisely adjust from pinpoint to blowtorch flame to meet exacting demands of the most critical job.

STANDS ITSELF: Place torch on flat working surface. Tripod formed by torch head and Multi-Fill provides firm three-point stand, leaving both hands free for holding, bending and turning operations.

CONVENIENT: Hole in torch head lets you store or temporarily hang torch, quickly, neatly in tool closet or on pegboard wall...ready for instant use.



ADAPTABLE: With quick-connect-disconnect adapter and stand, this Ronson Varaflame Torch becomes the control and power source for the new, lightweight Ronson Camp 'n Cook stove.

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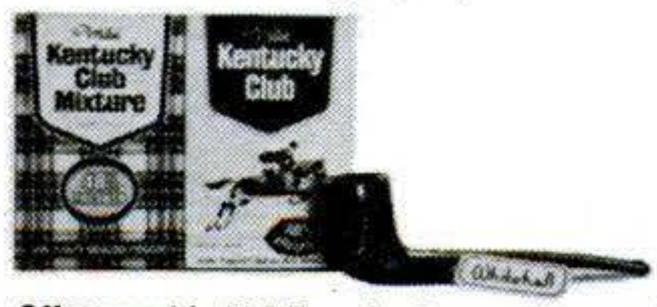

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PS Readers Talk Back

[*Continued*]

as the article implies. They *correct* myopia.

The story says that the lenses are sufficiently permeable that the oxygen requirements of the cornea are satisfied by oxygen passing through the lenses. Our research indicates that this is not true. The oxygen and tear exchange, we believe, is accomplished at the periphery of the lens.

W. ROBERT MELVILLE, VICE-PRES.
Ophthalmic Div., Bausch & Lomb
Rochester, N.Y.

Builds his own caboose camper

In Picture News [Jan.] you showed a K-Boose camper. Here is a similar one I

have used for over six years. It sleeps eight and is an exact reproduction of a B&O caboose used from 1918 to 1947. I started hauling it with a Jeep pickup, but have recently used a 4051 GMC diesel engine and five-speed transmission in a half-ton Chevrolet pickup for the job. I get speeds up to 70 m.p.h.

ANDY ANDERSON, Cromwell, Conn.

Citroën fans fight back

I take exception to Smokey Yunick's opinion of the Citroën [Dec. '68] that dollar for dollar it is in "nowheresville." It is an excellent high-speed car for any distance. Service facilities and parts are seldom a problem. Trade-in and resale are now quite good.

Dollar value is a matter of opinion. I prefer a car that handles well and goes where you want when you want to go, plus safety and comfort. I have yet to drive an American car that can match the Citroën. If by dollar value Smokey means horsepower and size, he is right.

G. M. BATEMAN JR., Sellersville, Pa.

. . . Smokey says the Citroën is not compatible with our superhighways. The Citroën is definitely compatible. The new models can cruise all day long at a speed of at least 90 m.p.h. and can attain speeds in excess of 120 m.p.h. They are frequently driven in Europe at that speed.

R. A. SALTWICK, Honolulu, Hawaii.

Continued

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TOM McCAHILL SAYS:

"There's no mystery to making money if you can repair these things"

The greatest detectives in history would be hard pressed to track down somebody to fix a bum toaster or dishwasher these days. It's funny: you have no trouble finding any number of so-called experts who'll fix a leaky pipe or a home run through the picture window. But electrical appliance repairmen are still as scarce as hippies in bathtubs.

If you're lucky enough to get a repairman to come from across town, he'll eventually have your bum dishwasher humming again like bees at a picnic. He'll also present you with an oversized bill. That's where the picnic ends.

If you're in the market for more money you don't need to be a super-sleuth to find it. Look for clues in your own hacienda. If you're typical, you own a couple dozen appliances, counting your wife's hair dryer, power tools and usual plug-ins like air conditioners, toasters, refrigerators, freezers, fry pans, and on and on. A lot of men like yourself have built rewarding full-time businesses after starting part-time earning $5 and more an hour fixing broken appliances. Others have found full-time jobs as Service Technicians. And when you hit Social Security years, think how great it would be to pick up a little extra cash doing as much Appliance Repair as you cared to do.

The Appliance Division of the National Radio Institute in Washington, D.C., has a great low-cost, home-study course covering every type of Appliance repair in detail—from toasters and irons to air conditioners, refrigeration equipment and one-lung gas engines. There's a section on farm and commercial appliances, too, if you're inertested in a big payoff, for when major appliances go kaput, they're as useful as moose antlers on a mouse.

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You'll be amazed at how easy NRI has made this course. Lessons are bite-size and loaded with photos and drawings so you see how each appliance comes apart—and goes together again. Men who felt they were as handy as icemen in the Arctic have nothing but praise for this great training.

The coupon below will get you a free NRI catalog with all the facts. There on it's up to you. No salesman is going to bother you. Do yourself a favor and mail the coupon today . . . tomorrow morning, for sure.

Tom McCahill

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PS Readers Talk Back

[*Continued*]

Holding onto PS is a real problem

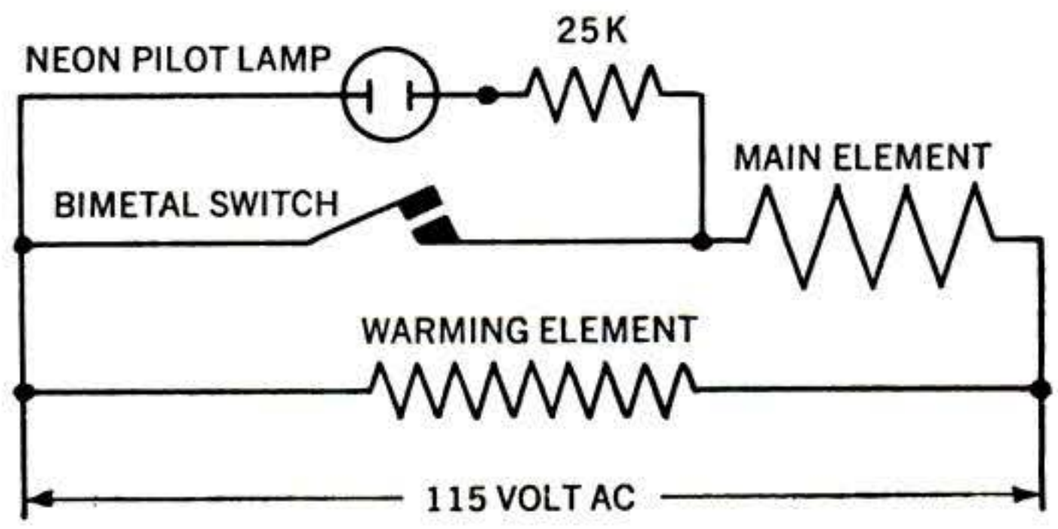
My husband reads PS from cover to cover. He used to read it during his breaks at work, but found he couldn't leave the magazine lying around because someone would steal it. He says it is understandable, but he's careful to read PS at home now.

MRS. A. L. TAYLOR JR., Bessemer, Ala.

Brewing up a new wiring scheme

The diagram showing a typical electric percolator schematic in "Repair Your Small Appliances" [Jan.] is wrong.

JOHN N. RICHARDSON, Hillsdale, N.J.



Inadvertently, the warm element circuit was shown on the wrong side of the main element. The diagram above is correct.

. . . Enjoyed your article on the repair of small home appliances. You mention that the most essential tool is a volt-ohm meter which costs about $11. I would like to know where to purchase one.

N. E. SQUIRE, North Olmstead, Ohio.

The meter shown in the article is a Claricon 76-850, an imported model carried by many radio- and TV-parts suppliers. It will soon be superseded by Claricon 76-853. If you can't get one of these, Allied Radio's 24C9318 ($8.95) or 24C9372 ($14.95) should be satisfactory.

"Wordless" has it soft

My face lit up over the "Wordless Workshop" woodcutter [Jan.]. Do I ever feel sorry for him. He has a chain saw. Now he needs a folding sawhorse for proper wood length! As a kid, I was sent to the woodpile to cut wood with an axe, bucksaw, or one-man saw. I sure used to feel sorry for myself, keeping that woodbox full. Now I feel sorry for Mr. Wordless. He's got it too easy with a chain saw and a folding horse to take the crick out of his back.

ERNEST KISON, Waltsburg, Wash.

Want to get something off your chest? Write "Readers Talk Back," POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y. 10017.

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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please *print* your name and address.

Can you really get stuck with a lemon? I recently acquired a Triumph 250. At 1,300 miles, the disk brakes failed, and I waited two weeks for repair parts. At 6,000 miles, the transmission fell apart. That fixed, I got 250 more miles and the rear end dropped out. That was two months ago and I'm still awaiting parts. Also: windows don't roll up completely, signal lights don't work, driver's door won't close properly, steering column is loose. All dealings with local and West Coast distributors and dealers have been to no avail.

SGT. W. J. NOELL, U.S.M.C.

Be honest with yourself, Sergeant—are you sure you haven't been making like Dan Gurney at Le Mans? If you have truly broken in this car reasonably, then either you have a lemon—a car put together by people who didn't know how, or don't give a damn—or your dealers have people with the same disease. Change makes; when car and owner get that slantwise to each other, divorce is the only answer.

I have a fuel-pump knock that I can't get rid of in my '67 Plymouth. I've had three new pumps put in and still get knock. They told me on the last installation to run the car 30 days, that sometimes the knock will work out—but it didn't. The knock is there at all speeds, but worse when I start up after the car stands for a while. What should I do next?

L. D. MALLAN, Albert Lea, Minn.

You're on the right track. Chrysler's latest pump is the best one I know of. Your best bet: Keep up with Chrysler bulletins as they try to work out what seems a tough problem to lick. If you can't get used to the knock, you could throw away the mechanical pump and try an electric fuel pump.

My '68 Olds Delta 88 with power steering has steered stiffly, with poor return to center after a turn, ever since it was new. At 7,600 miles it has been to the dealer about a dozen times. The steering column when disconnected from the power-steering unit runs free, so it isn't in the column bearings. They lubricated the front end twice, changed the power-steering unit, and checked pump pressures. Last week the pitman arm was disconnected with the car on the rack and it took much force to turn the front wheels. Lubricating the ball joints didn't help. The dealer says he will do no more. Can you suggest anything?

F. A. SPENCER, Skokie, Ill.

It steers stiff because the power steering is too weak. Take it to a power-steering expert and have him find out why the pump output is so low. When that power steering is right, you can steer it with one finger, even at low speed. That's the purpose of it—to give you control. Don't settle for less.

My '65 Dodge Dart wagon has the 225-cu.-in. slant-six and automatic transmission. Would a four-barrel carb with matching manifold increase performance? Would I need a different cam? Also, should I change transmission fluid every two years, or less?

MIKE BROIDA, Rochester, N.Y.

A four-barrel would help top-end performance, but I doubt if it would help the low end. Changing cams would help, but only in the midrange and top end—not the low,

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Renault's 65mph screeching-halt test with no hands.

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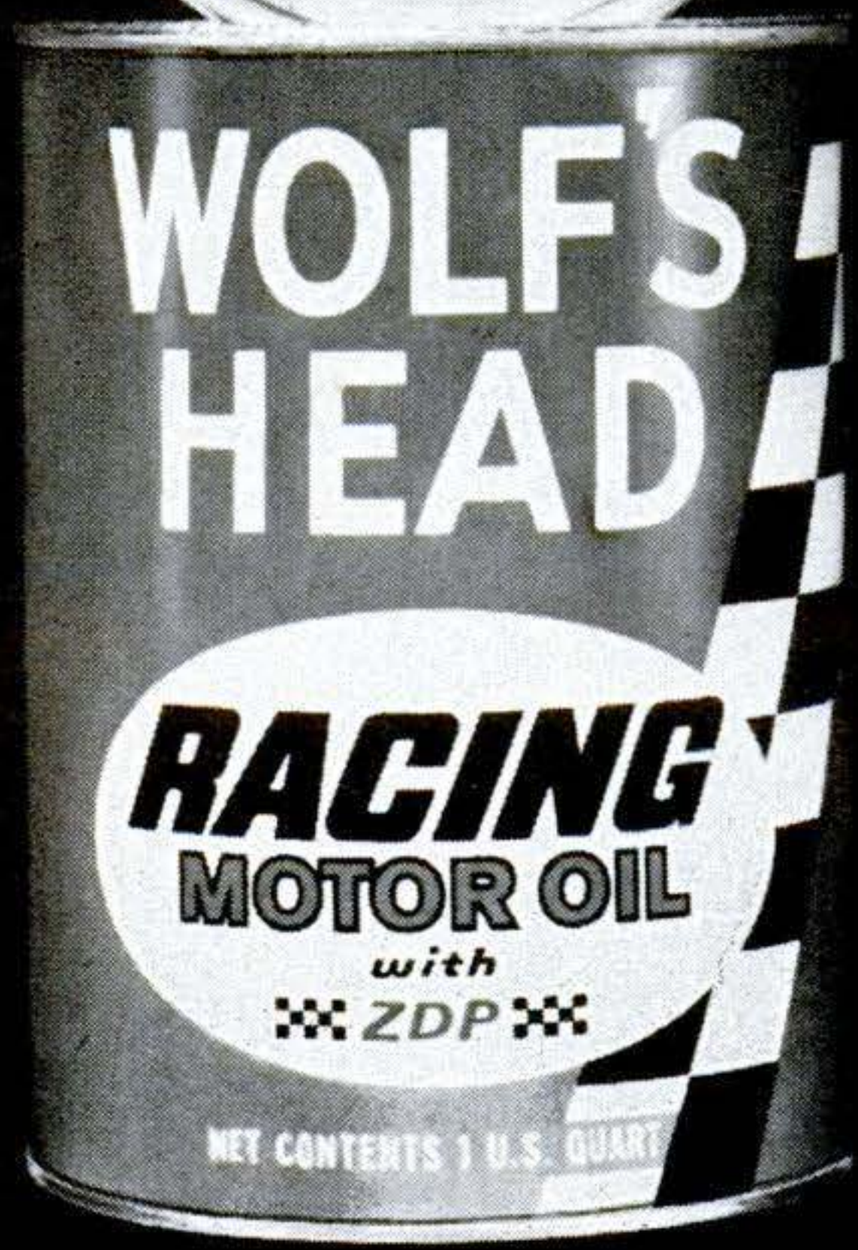

the uncommon motor oil

where it would hurt performance. You won't be wasting money changing transmission oil even oftener than every two years.

Rocker-arm stud height varies on both heads of my '66 Pontiac Catalina (389 engine). The repair-manual spec for lifter travel is .125". When you run the rocker-stud retainer nuts down to the recommended torque (20, plus or minus five foot-pounds) with valve stems of different height, some valve lifters are not being operated in the center of their stroke. Also, nuts work loose. Studs are ⅜"-24 thread. Is there some conversion I can use other than nuts? According to my calculations, running each lifter down 1½ turns from zero lash should position each lifter in the center of its total ⅛" travel, regardless of valve-stem height or rocker-stud height. Please help.

M. Houke, Indianapolis.

I believe it would work real good with .100" to .125" lifter penetration. Lock up any way you can—spec. nuts, pal nuts, Loctite, or anything you can find that will really lock. But of course the valve-stem height should be the same, and the stud height the same, then the torque. Forget the automatic correcting adjustment. Production methods and sloppy mechanics, of course, sometimes make this impossible. You're on the right track—just finish it.

I have a 1968 Camaro six. When I turn off the ignition, the engine continues to turn over two or three times. The dealer put a solenoid kit on the carburetor, but it was no help. Also, any time from one to 20 minutes after the turn-off, gasoline pumps out of the base of the carb—from a few drops to a half cup. The dealer has replaced the carburetor and fuel pump, and raised the carb with a bakelite block. No help from this, either.

Charles Lamb, Winter Park, Fla.

The only thing I know of at this stage is to play with the timing, which is a hit-or-miss fix, and slow the idling to the minimum. This problem—apparently a spin-off of the giant smog-control mystery—seems to have no definite fix.

At 2,000 miles, my 1967 Ford F-100 pickup with 240-cu.-in. engine began a rocker-arm squeak. Since then, all the rocker arms have been replaced twice, and the push rods and lifters once. At 5,500 miles, the problem still persists. There is a knock in the engine

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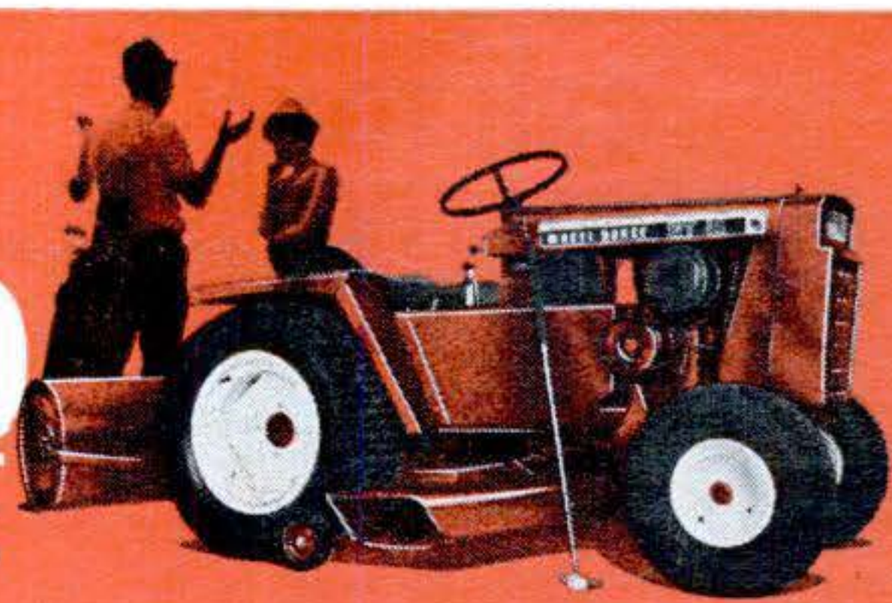
BIG THOROBRED



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"Say, Smokey—"
[*Continued*]

on acceleration when cold; after it warms it quiets down. What's wrong?
WARREN HENDERSHOT, Lower Salem, Ohio.

What's wrong? What's right? Get right back to that dealer. Your oiling system has quit work in the valve-train department. That knock is probably an S.O.S. message that one or more pistons have too much clearance until the engine gets hot.

Why do mechanics insist on replacing points and *condensers during a tune-up? Seems to me, the condensers should last through two or more sets of points. Is there any danger in replacing the points alone?*
I. GOLDMAN, Brooklyn, N.Y.

It all started years ago when there were no condenser testers to speak of and points burned quite often. Since it sells lots of condensers, nobody in the business has been anxious to start a crusade to save old condensers. On the other hand, sometimes they do leak or have other trouble, so the real answer is to test them. If the condenser is good, you can leave it in with no danger to new points. But if it goes bad shortly after and shortens the life of the points, then look out for the Change-the-Condenser-When-You-Change-the-Points Club.

I've bought a one-owner '61 Rambler for a second car. It has a believable 25,000 miles on its aluminum engine and hasn't used any oil in 1,100 miles. But a diagnostic clinic showed noisy rod bearings; and inspection by the local dealer, some warpage. Most Rambler dealers recommend replacement with a cast-iron engine, but they run close to $468 installed, since Ward and Sears won't take the aluminum block in trade. Would you recommend replacement of the rod bearings, a later-model used engine, or a new engine?
CHARLES W. ENLIND, Arlington, Va.

Good aluminum engines for production cars are on the way, but they certainly hadn't started with that model. My honest opinion is that you should get rid of that car, for you have a bear by the tail there. If you insist on repairing it, get a rebuilt cast-iron engine; you'll never fix that one.

Got a question on autos? Send it to:
"Say, Smokey—" POPULAR SCIENCE
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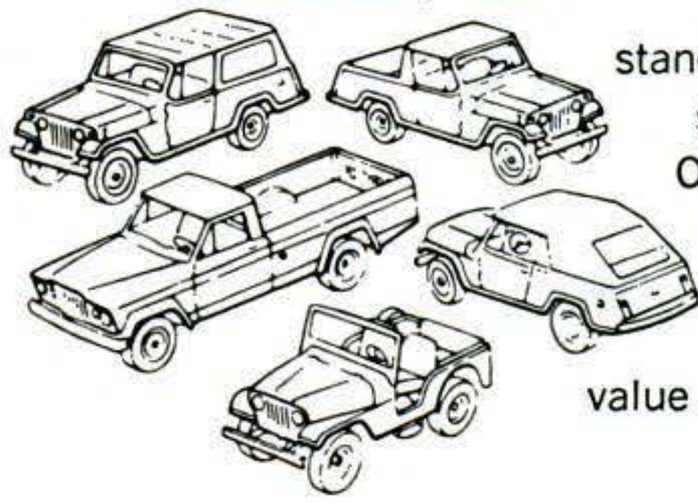
'Jeep' 4-wheel drive
The 2-Car Cars.

Part Dan Boone.

Part Don Juan.

'Jeep' 4-wheel drive.



This 'Jeep' Wagoneer looks as much at home around the country club as it does around the campfire. It's a great family wagon. Handsome. Sturdy. Roomy. Then, flip one lever into 'Jeep' 4-wheel drive . . . you've got a different breed of car! Rough stuff? Rocks? Mud? Sand? Don't worry. 4-wheel drive is standard equipment. So are chair-height seats and "picture window" visibility. Options include V-8. Automatic transmission. Power steering. The works. Test drive the 2-Car Cars at your 'Jeep' dealer. And ask about resale value . . . 'Jeep' ruggedness never goes out of style. 'Jeep' 4-wheel drive. You've got to drive it to believe it.

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Science Newsfront

Last-minute news and notes to keep you up-to-date

By W. STEVENSON BACON

Superconducting cables like this prototype could carry huge blocks of power into the core of our expanding cities. The cables, under study of GE, are cooled by liquid helium to the point where they lose all their resistance.

The Loch Ness monster may have been spotted by a new sonar device. The topic of whether "Nessie" really exists or not has long been debated—both in Scotland and abroad [see PS, Nov., 1966]. Now indisputable data shows there is *something* under the waters of the lake, and that it's quite large and moves fast. During August, 1968, according to the journal *New Scientist*, researchers from the University of Birmingham searched the waters of the loch with a 50-kHz "digital sonar." The findings: On Aug. 28 a large object at least 164 feet long and maybe as much as 100 feet high was spotted moving at 7.5 m.p.h. Other sonar "pictures" show something about 10 feet long moving at 17 m.p.h.

Crash your car at 60 m.p.h. and survive? You can, along some Texas freeways that have reduced the hazard of crashes with stationary roadside objects such as abutments. The answer is simple, economical "crash cushions." Researchers at Texas A&M strapped together 30 ordinary 55-gallon oil drums (empty) to make the first cushion. In a test, a car traveling at 60 m.p.h. was halted in just 14 feet with moderate front-end damage, headlights still intact. (Normally such a crash would push the engine back into the front seat.) Barrel networks are now being installed in a number of Texas locations under the sponsorship of the U.S. Bureau of Public Roads and the Texas Highway Department.

A computer-simulated chemical reaction has made possible the production of a new compound. In an amazing technique, mathematical formulas fed to a computer result in the "mixing" of chemicals right down to the interactions between atoms and electrons. These fleeting interactions can be viewed on a TV screen and stopped at any point. In pioneering experiments, Dr. Enrico Clementi of IBM found that ammonium chloride can exist as a gas; the computer pinpointed the right temperature and pressure needed to make it. (Independent researchers then produced it.) The computer results are said to be just as valid as actual experiments—this because mathematics fully and completely describe each atom.

A pint-size furnace that heats a whole house may revolutionize the field. Although details are not available, the coffee-can-size device is said to transfer heat from burning gas (natural, manufactured, or LP) to liquid or air "through an ingenious arrangement resulting in an extraordinary level of turbulence." Just inches in diameter, the tiny heat generator could make your furnace simply a part of the plumbing. The device came out of work being done by Raytheon to find better ways to cool high-power electronic tubes, and one of the units is being used to heat the laboratory in which it was developed. Amana Refrigeration, Inc., is refining it for home use.

A nuclear-powered piston engine is in the talking stage—at least in Yugoslavia. It com-

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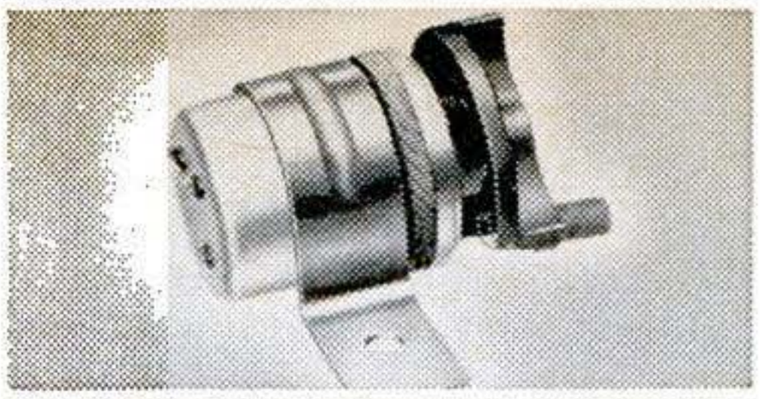

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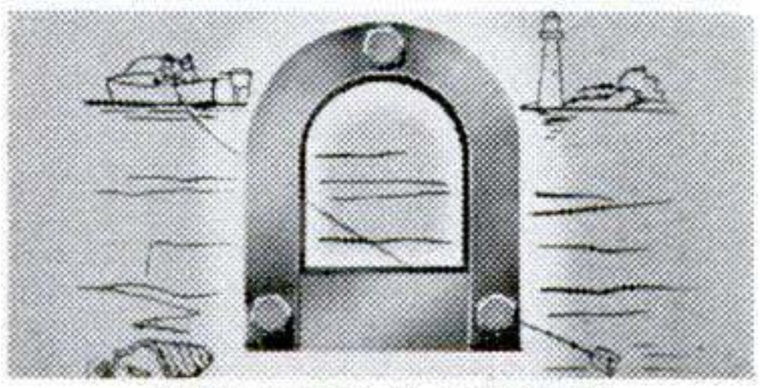

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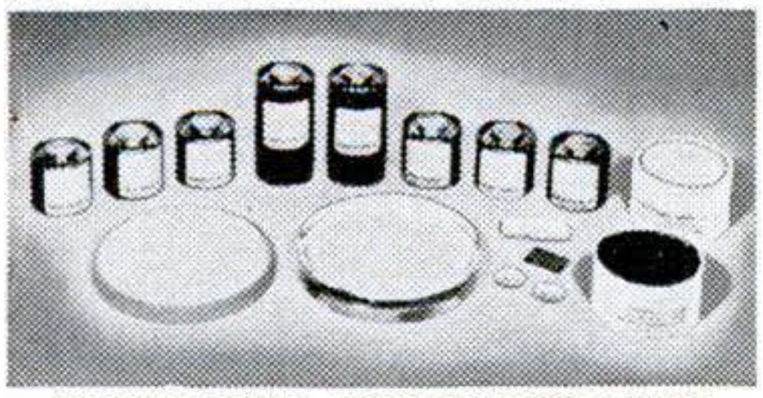

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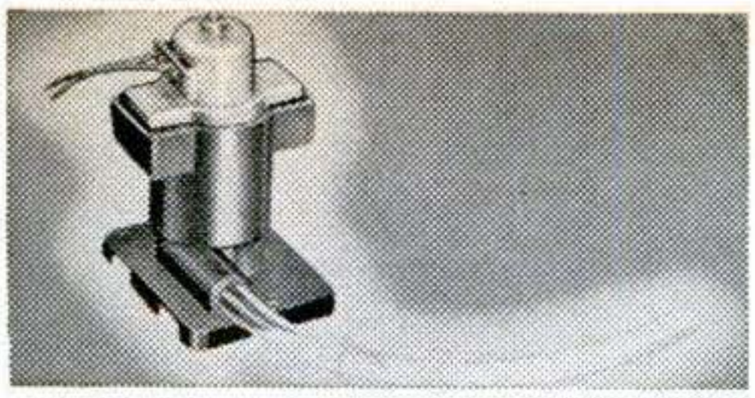

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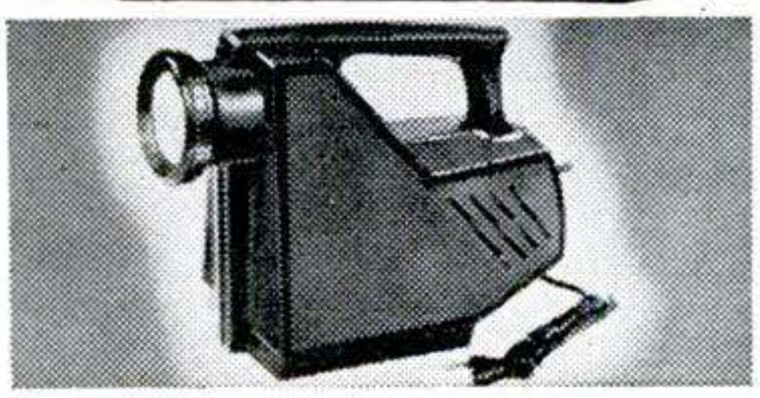

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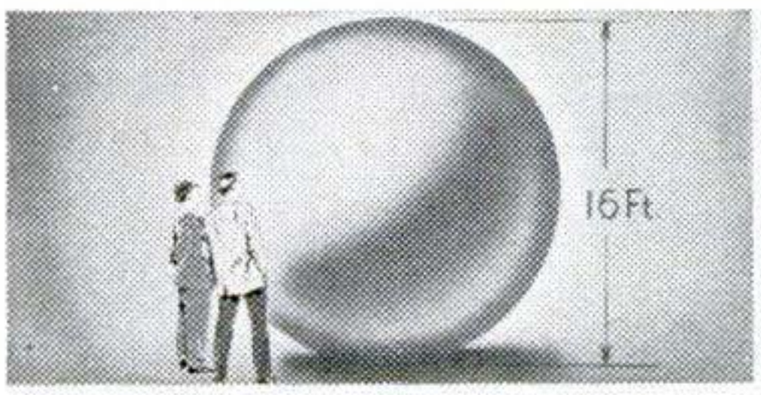

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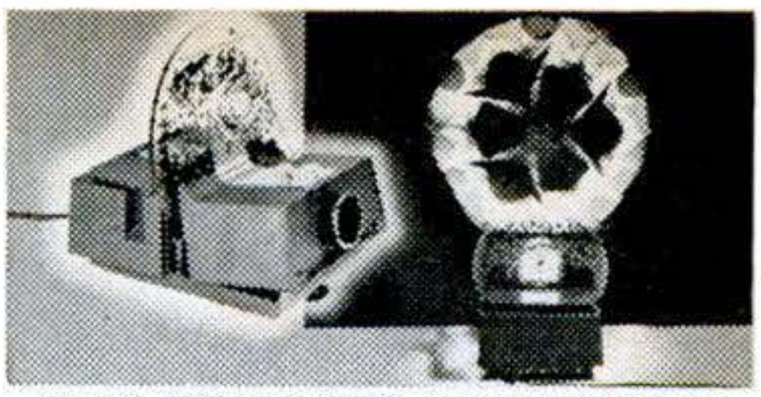

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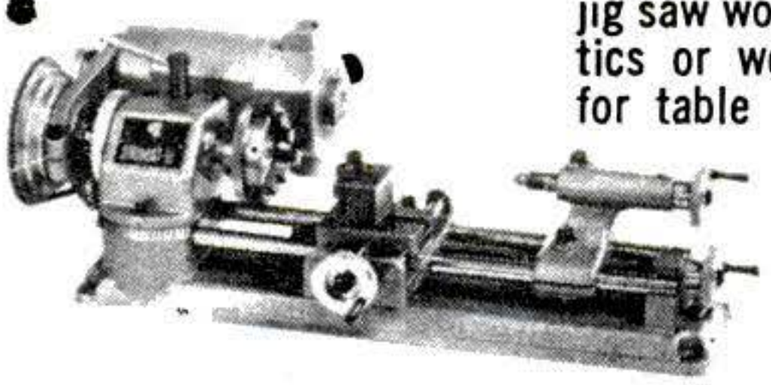

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bines the 149-year-old hot-air Stirling engin with man's latest heat source, the nuclear r actor. Stirling engines use a sealed-in worl ing fluid (gas) to which heat is added throug a heat exchanger. The heat drives a pistor a second piston or "displacer" then sucks th gas back through a cooler and recompresse it to be heated again. [See "New Engine f Space Does Down-to-Earth Jobs," PS, Jul 1965.] Yugoslavian researchers reason tha a power plant using Stirling engines to tur generators would be very compact and eff cient. It would not require boilers, con densers, or recuperators, but simply a sma heat exchanger.

If you have car trouble, the best place to be i a lonely country road. If it happens on a bus freeway, start walking. Why? Because th more people who see your distress, the les likely you are to get help. If one motoris spots you on a deserted stretch you may ge a lift. This conclusion is drawn by Dr. Bib Latane of Ohio State, who is researching by stander intervention in emergency situations His explanation: When there are othe people to share the responsibility, we fee less obligated to do something.

Helicopter mobility has made a great chang in how men and machines are moved durin a limited war, but it's impossible to move striking force without a lot of aircraft. Un fortunately, formation flying with helicopter is impossible at night or in bad weather Now, a computer command device is bein developed for use in the lead helicopter tha could keep up to 25 choppers in exact follow the-leader formation. In a University o Pennsylvania project for the Army, Dr. Ken neth A. Fegley is determining what dat needs to be sent between the choppers, an how fast it has to be transmitted. The com pleted system will control takeoff, climb-out and rendezvous. It will assign each aircraft place in formation and issue appropriate cor rective commands. Finally, it will contro breakaway and landing patterns.

If you're taking antibiotics, stop dieting—or a least avoid artificial sweeteners. A strange unsuspected interaction between lincomycin hydrochloride, a common antibiotic for con trolling bacterial infections, and sodium o calcium cyclamate (the sweetener) seems t block the drug from being absorbed into th bloodstream and thus keeps it from reachin the site of the infection. This effect was foun in experiments conducted by Prof. John G Wagner of the University of Michigan, wh

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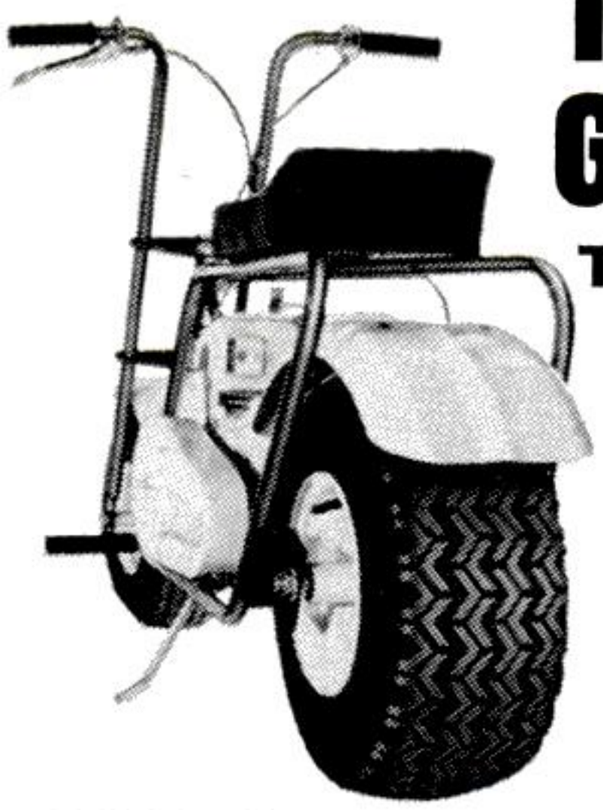

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also discovered that absorption of the dru is cut about 75 percent. Cyclamates are use in many diet foods and drinks, and, to date have been used to improve the taste of anti biotics in liquid form!

A new way of testing metals for airplanes an other purposes uses holograms to show exactly how much strain a material can take It's done by making a hologram of a sampl before placing it under a load. The illumi nated image is then superimposed on th

metal itself. When it is loaded (as by the pointed bearing in the photo), deformations in the surface can be easily seen as interference fringe patterns. Advantages of the new metal-testing technique developed by Bell Labs: Nothing has to be mounted or coated on the metal surface; new holograms can be made at any point so deformation can continue indefinitely; the hologram can be made at maximum load and the metal studied as it is gradually removed.

An unsung hero of the space age is Mrs. Arlene VanEtta of Bangor, Pa., who specializes in hand repair of nylon stockings. Those excellent TV pictures of the moon and the interior of Apollo 8 seen last December were made possible by a high-gain dish antenna designed to operate at extremely high S-band frequencies (2,282.5 mHz). This antenna was solid and performed very well, but a similar unit designed to be carried down to the moon's surface has to be collapsible and is thus being made of gold-coated meshing. Unfortunately, practicing astronauts have a tendency to punch holes in the mesh. The solution? Hire Mrs. VanEtta to reweave broken antennas. If all goes well, the collapsible dish, to be supplied by RCA, will this year relay to earth live TV pictures from the surface of the moon. PS

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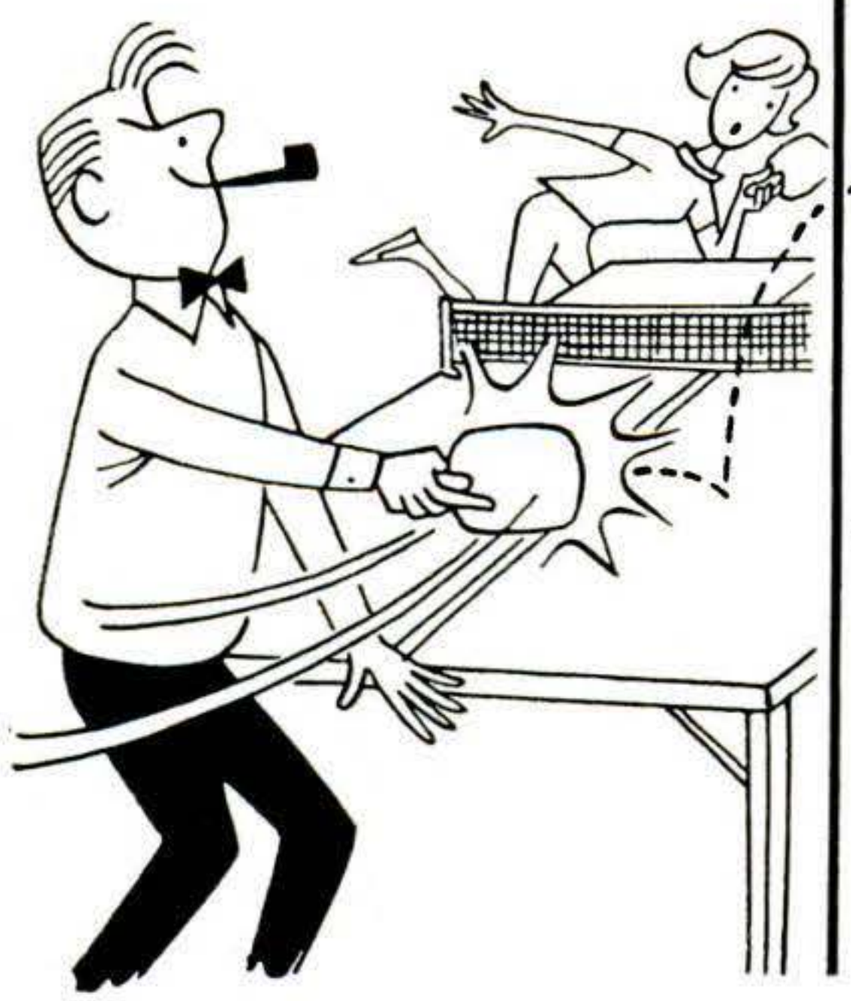

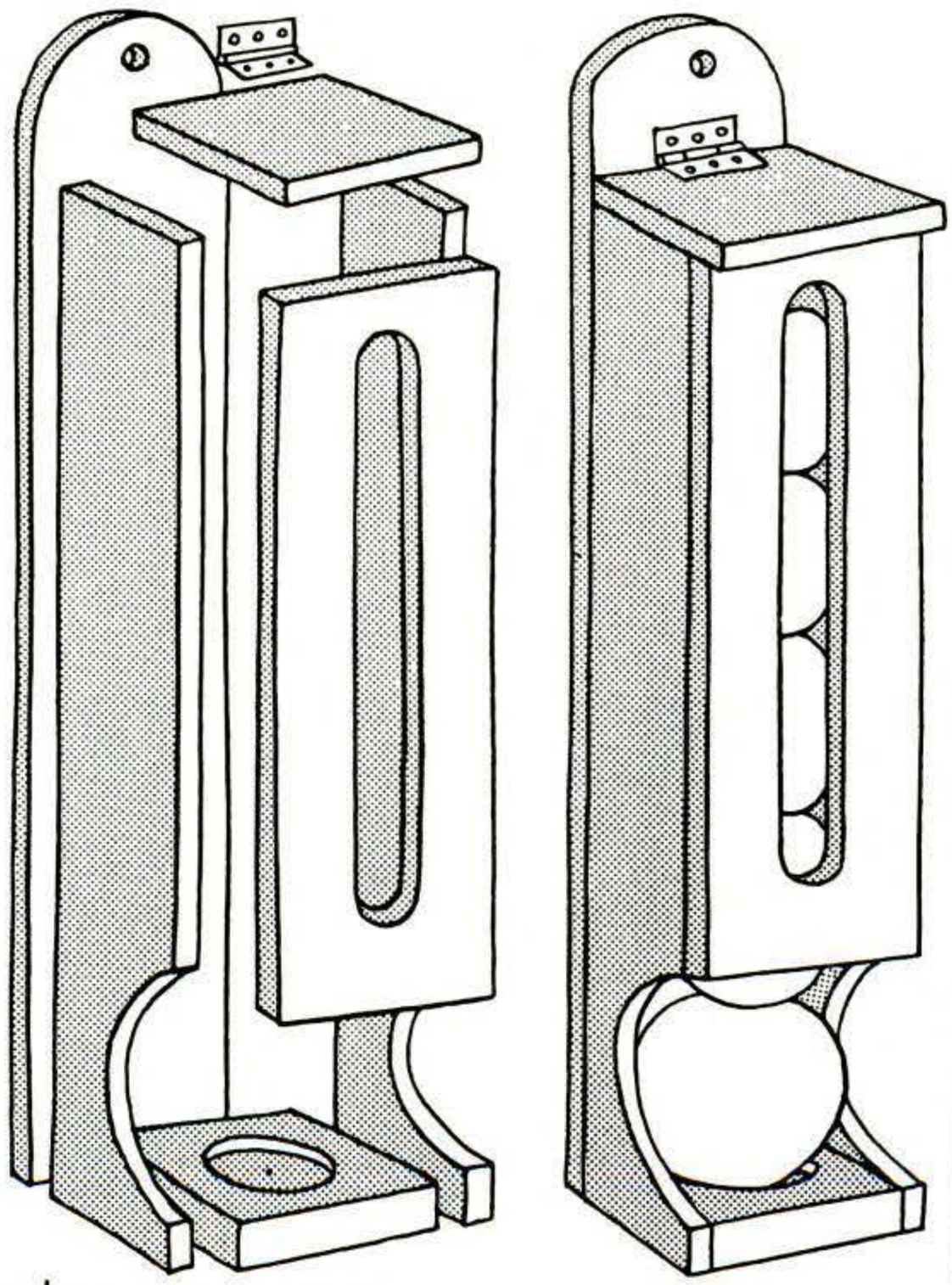

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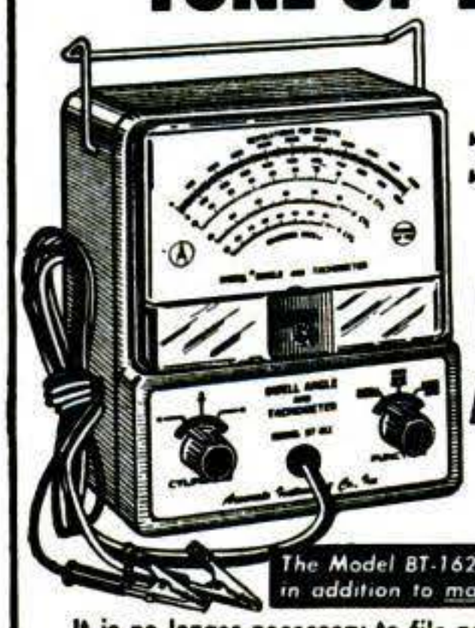

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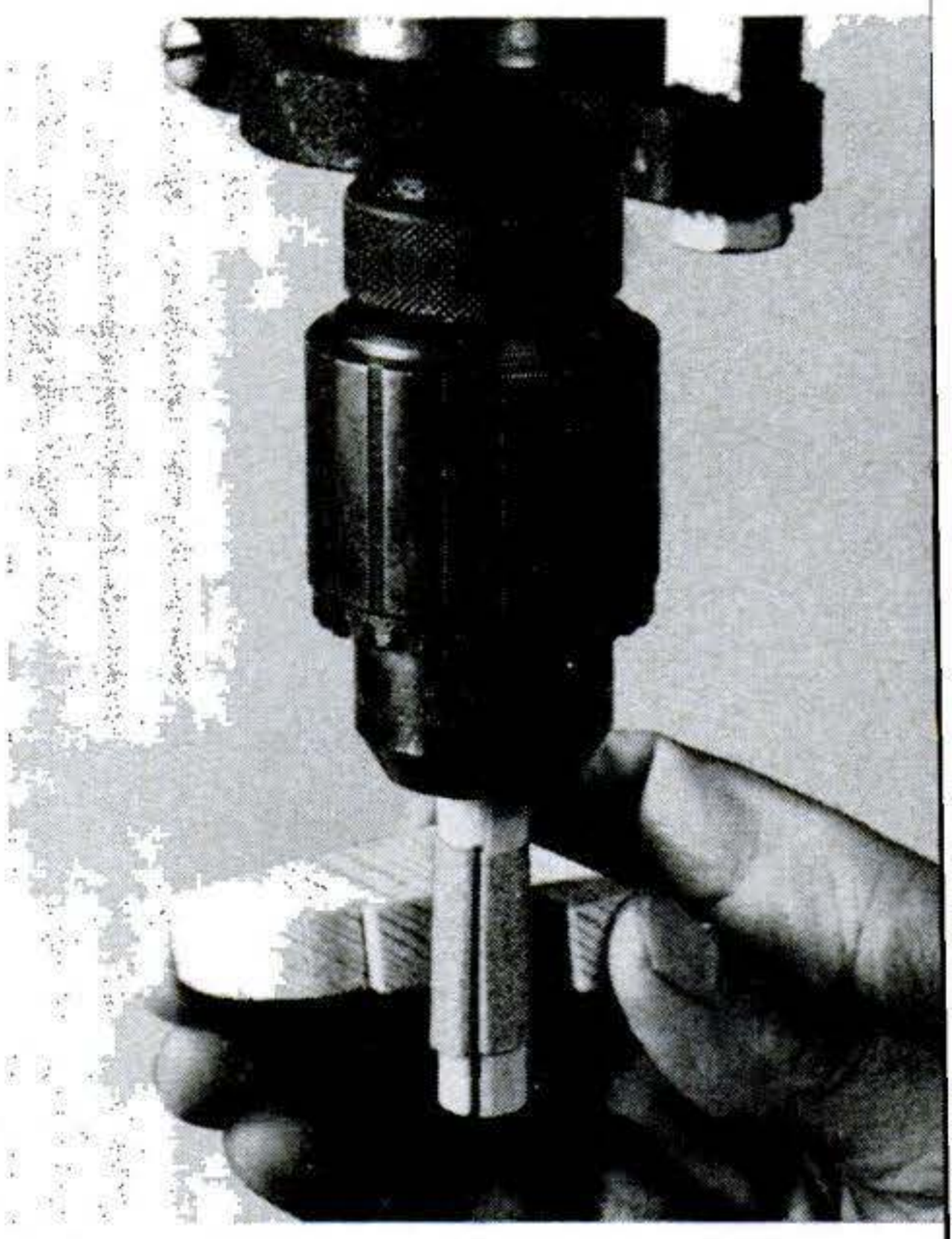
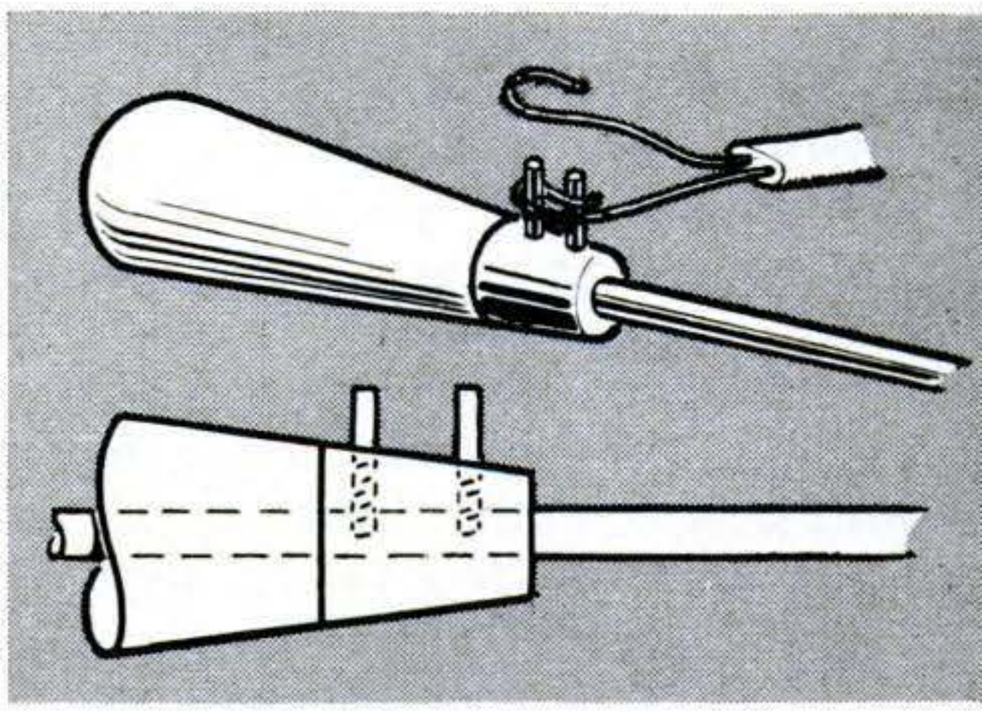


Dowel makes miniature sanding drum

For quick and easy no-spots-missed sanding of small inside curves, and other areas, chuck a tiny sanding drum like this in a drill press or hand drill. To make the drum, slit the end of a dowel and fit a piece of sandpaper around it with both ends tucked into the slit.

JONATHAN HAND, Westport, Conn.



Electrician's screwdriver bends wire

This two-in-one tool saves time when you're bending connecting loops. Drill and tap two 8-32 holes through the driver's ferrule into the shank. Space them to receive standard sizes of wire and insert headless screws or threaded pins.

PETER LEGON, Malden, Mass.

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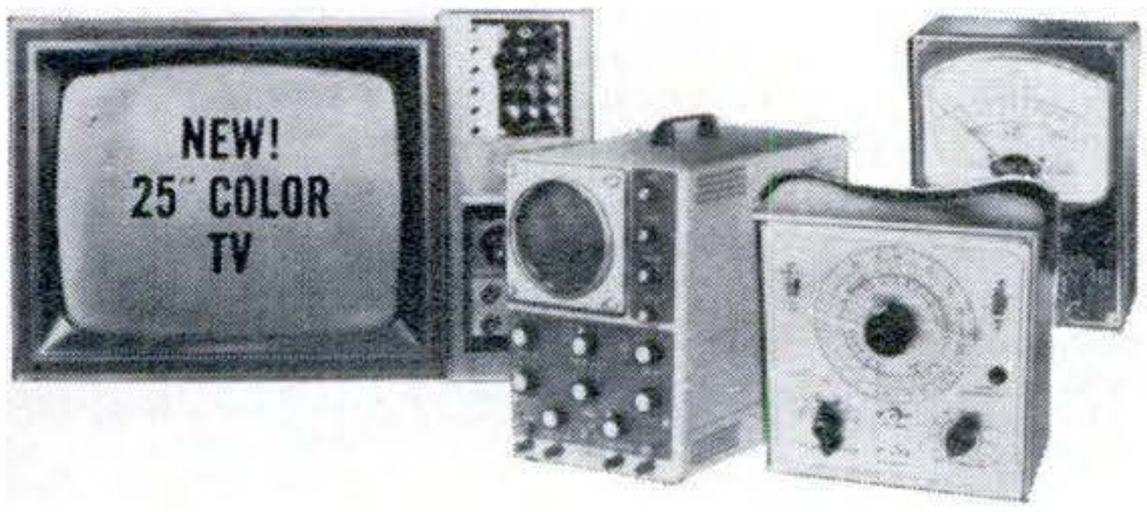

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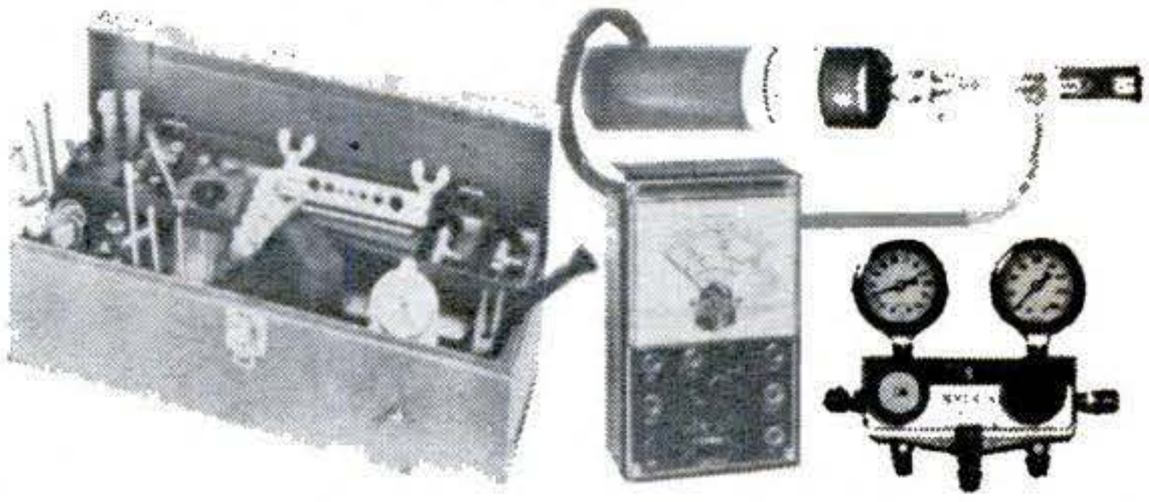

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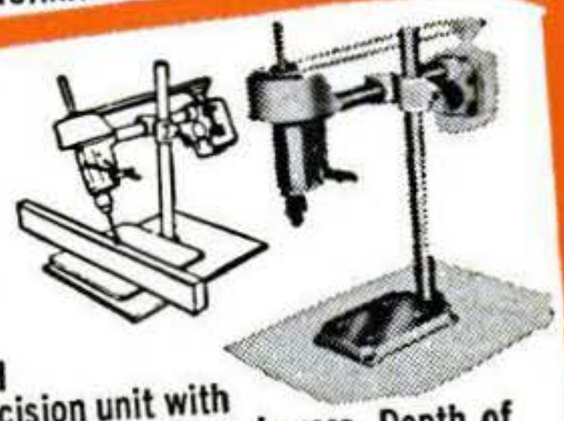

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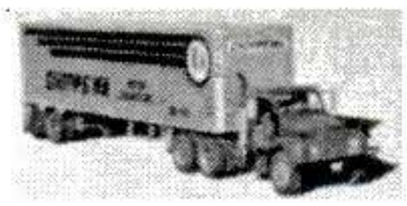

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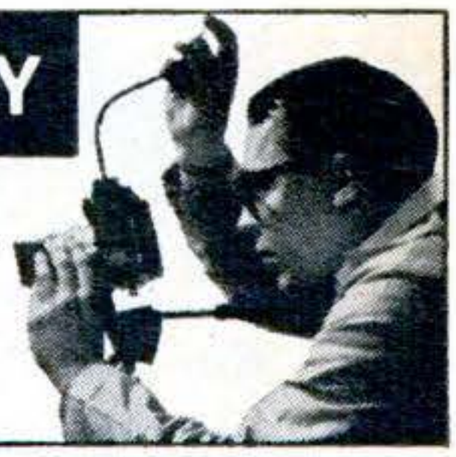

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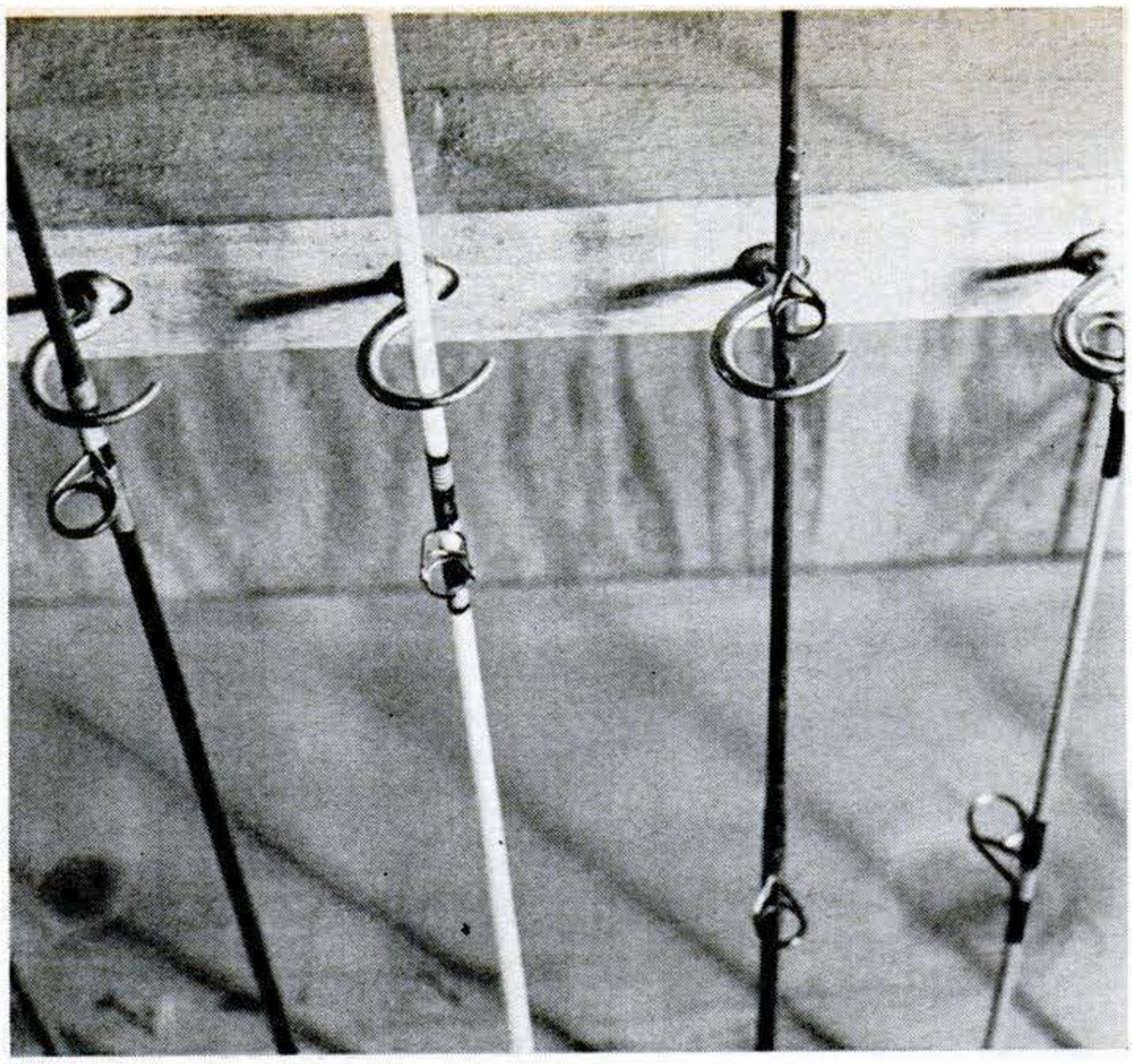
SHORT CUTS AND TIPS

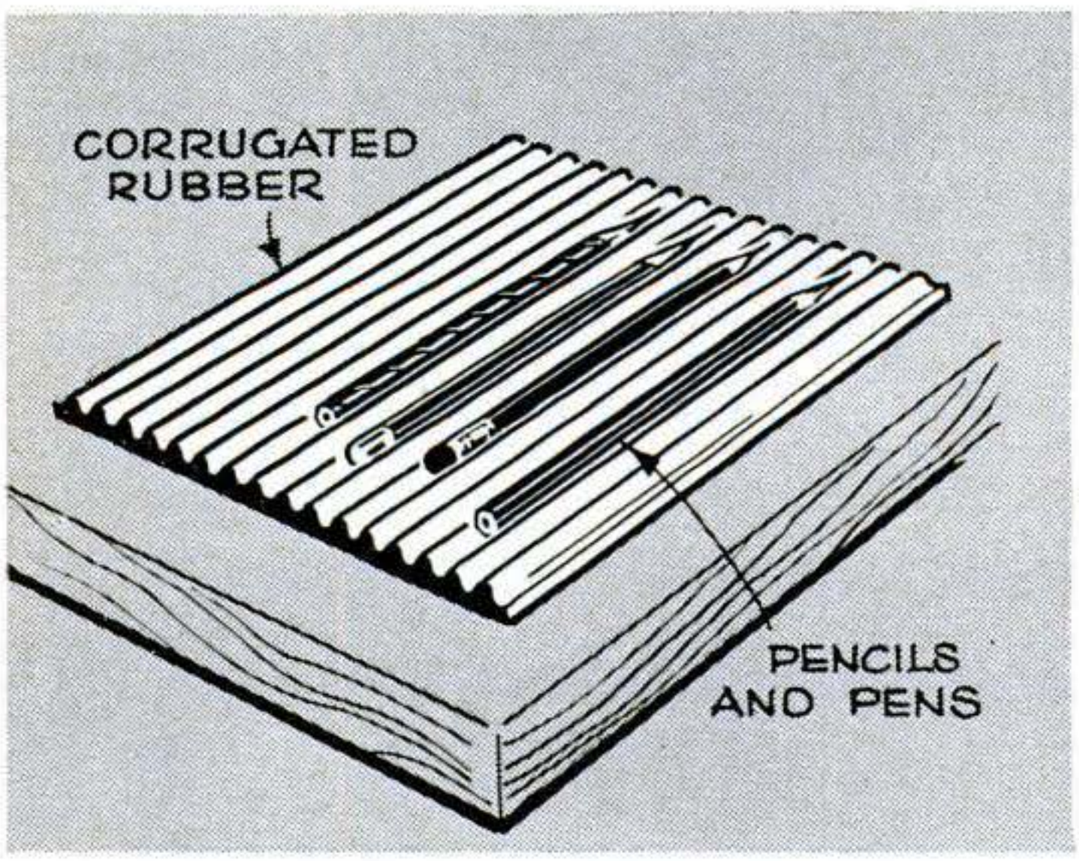
FROM HERE AND THERE

Use oversize cup hooks to store your fishing rods

Here's an easy—and convenient—way to store fishing rods: Screw two 1¼″ cup hooks into the ceiling joists for each rod. Space them so that one is just above the grip, the other at the tip. By running the rods at right angle to the joists you can hang all the rods you own. Four joists (48″) is just about right for most fresh-water rods.

C. Boyd Pfeiffer
Baltimore, Md.

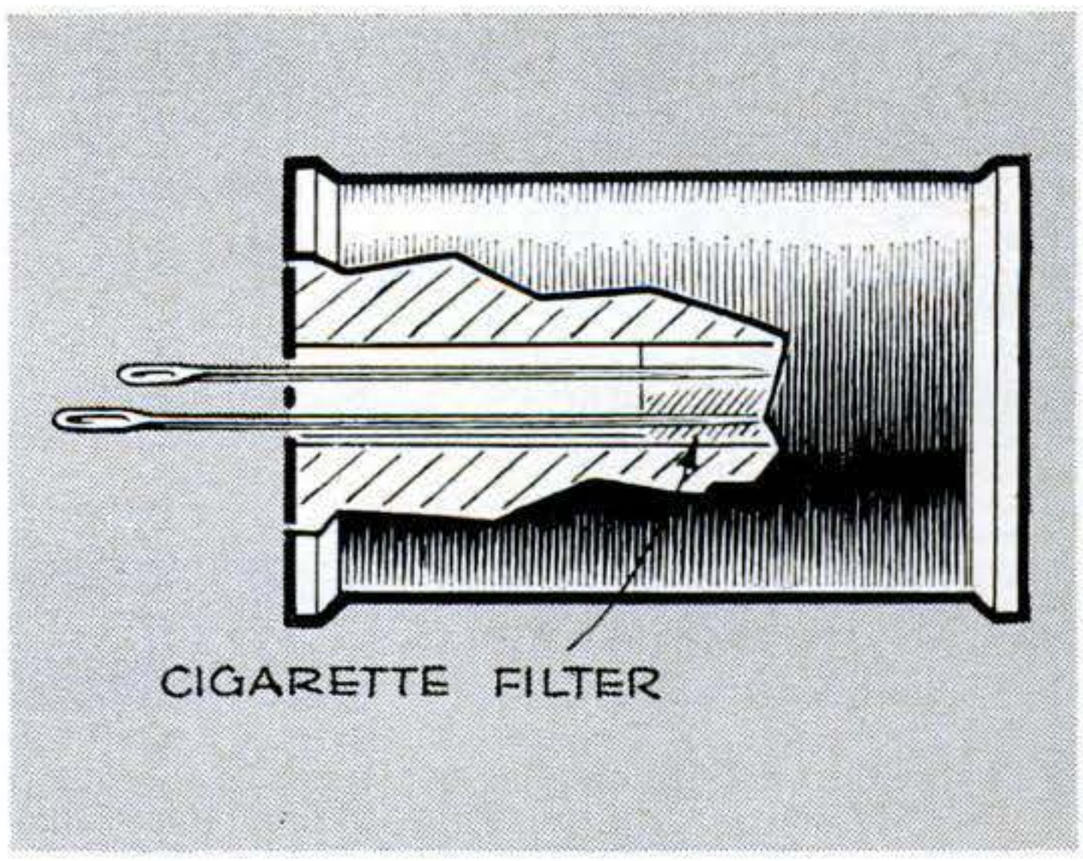




Rubber mat holds pens and pencils

Tack a piece of corrugated rubber to your workbench and pens and pencils will stay put instead of rolling around. Make an extra one for drafting tools and small brushes.

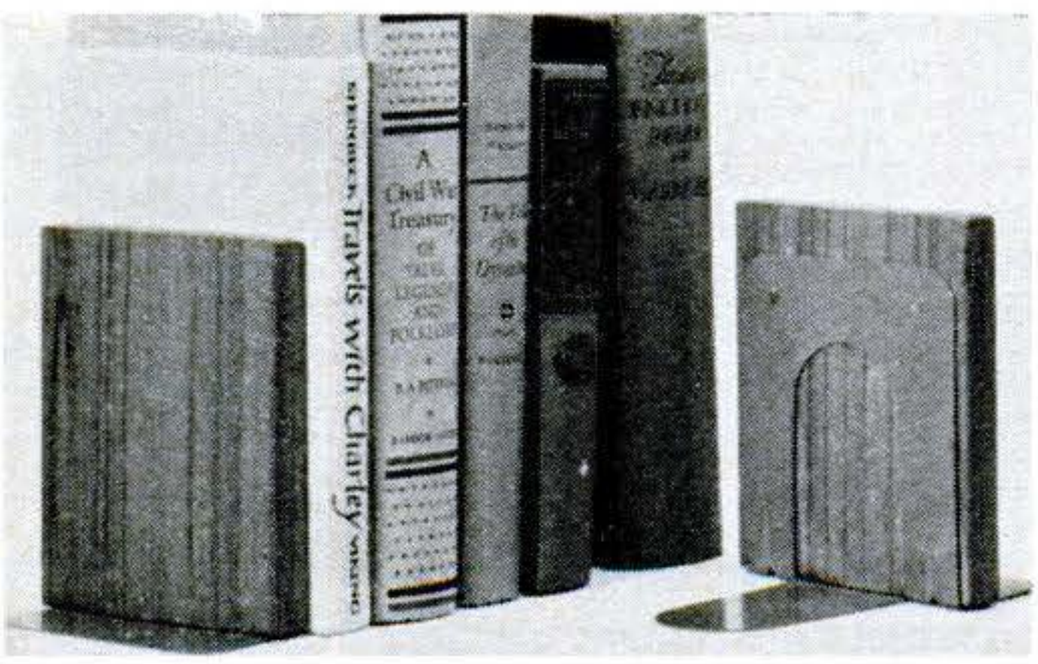
Victor Lamoy, Upper Jay, N.Y.



Tell your wife about this, too

Keep a few sewing needles handy for splinter removal by poking them into a cigarette filter inserted in a thread-spool hole. Flame the needle point before use.

Neill Kirby, San Bernardino, Calif.



Fast way to beautify metal bookends

Ordinary stamped-metal bookends from the five-and-dime store are good looking enough for the library table with this trick. Cut pieces of wood slightly bigger than the vertical legs and fasten them as shown with small screws or epoxy glue. Pick a wood that matches the table or your bookshelves. As a variation, cement hardboard or heavy cardboard instead of wood, and cover with wallpaper from your last papering job.

Jackson Hand, Westport, Conn.

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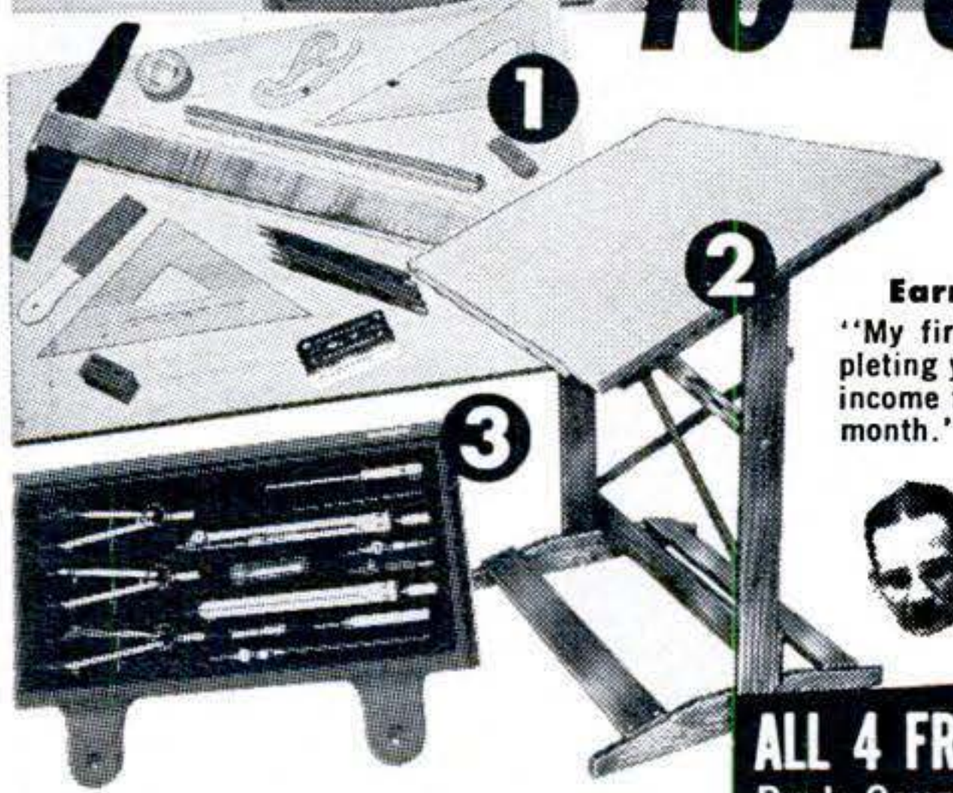

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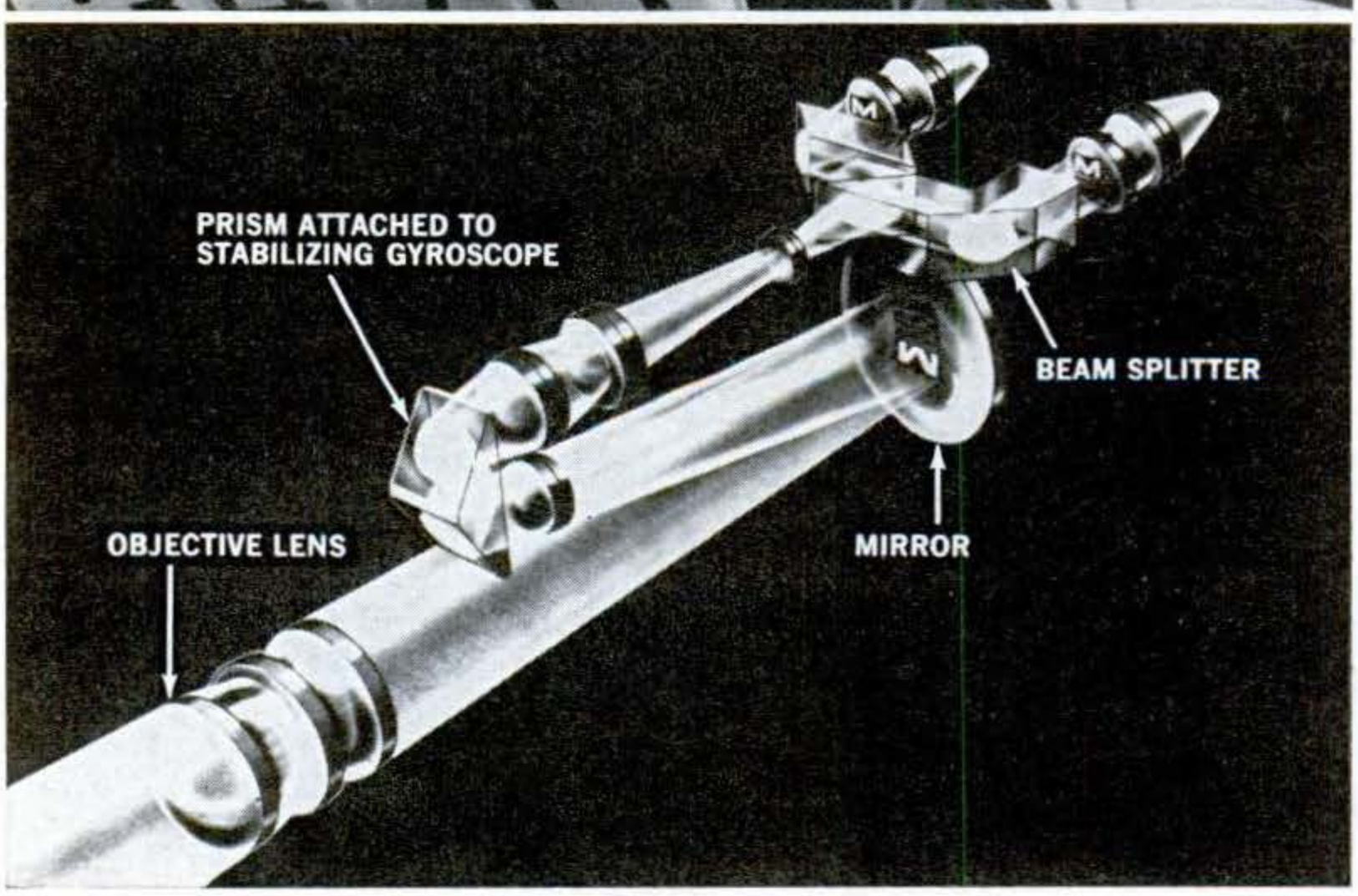

Gyro steadies binocular's magnified image

Even when subjected to the vibration of a helicopter (left) this new binocular gives a stabilized image up to 20-times magnification. The secret is a built-in gyroscope, said to be available for the first time in a self-contained unit about the size of a shoebox.

The gyro, driven by a small DC motor, is mounted directly to the stabilizer prism (see drawing). Three penlight batteries normally supply power, but the unit has a socket for an external power source. Controls include on/off switches for motor and stabilizer, and a magnification button for selecting 10- or 20-power viewing. The new $4,500 optical instrument is made by Mark Systems, Inc., Cupertino, Calif.

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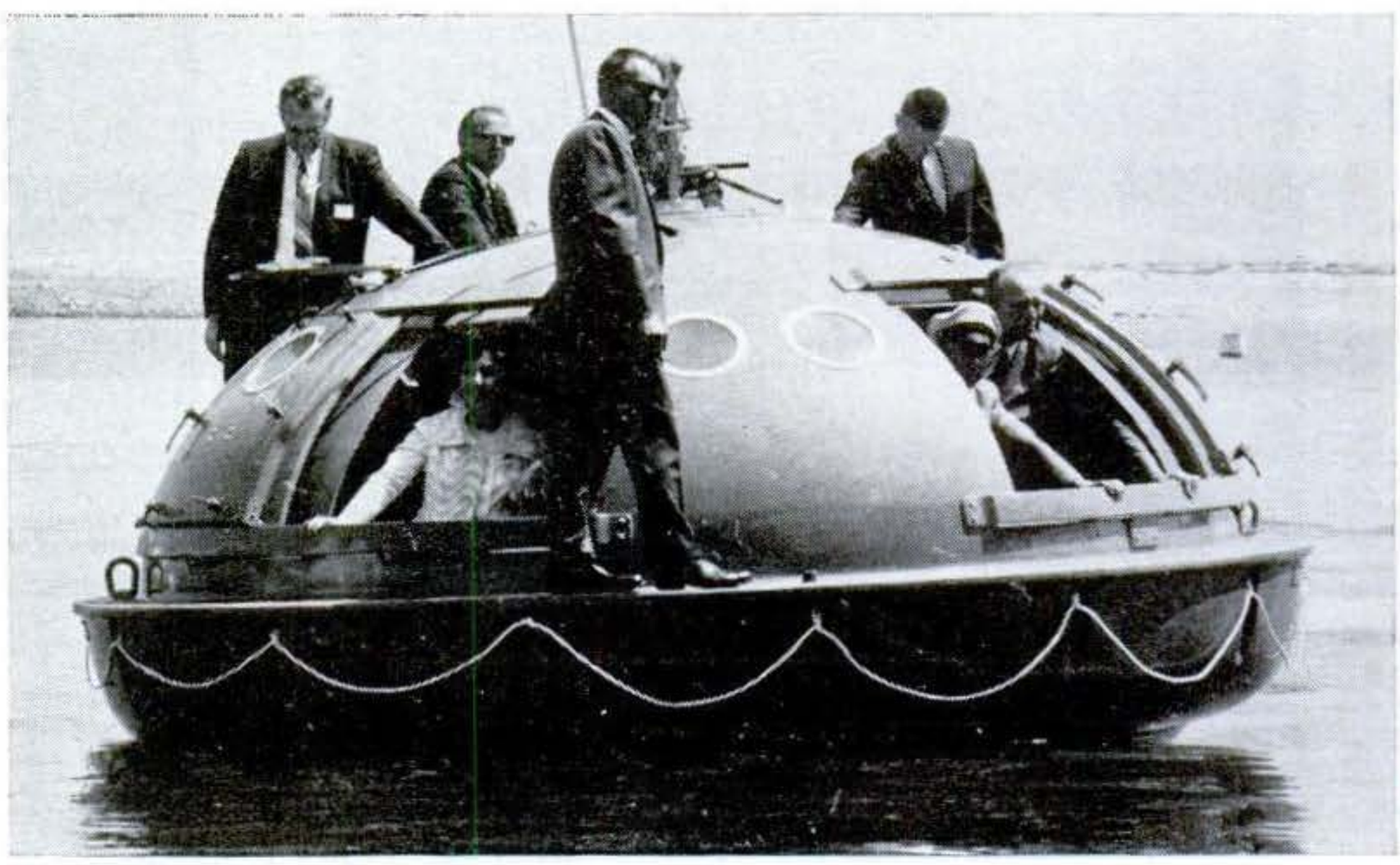

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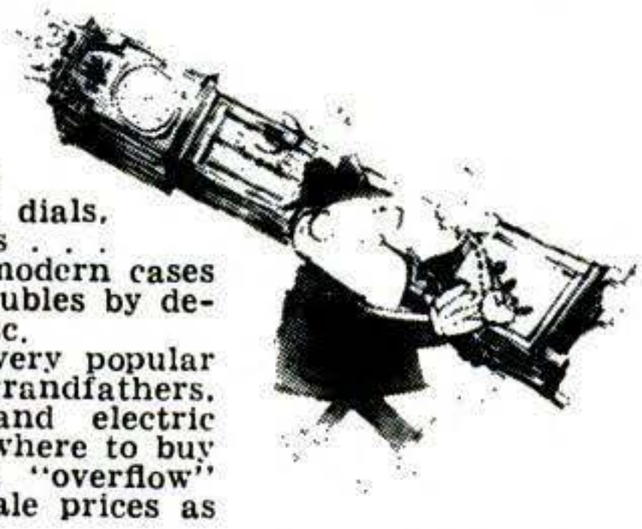

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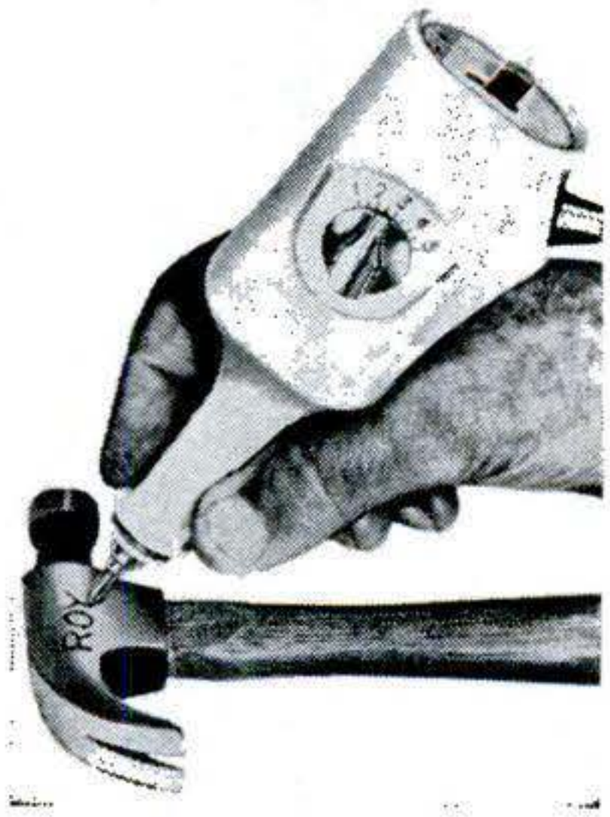

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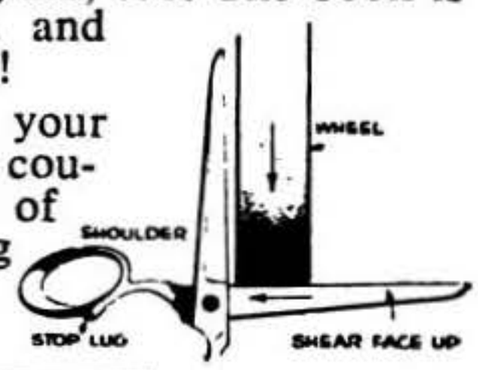

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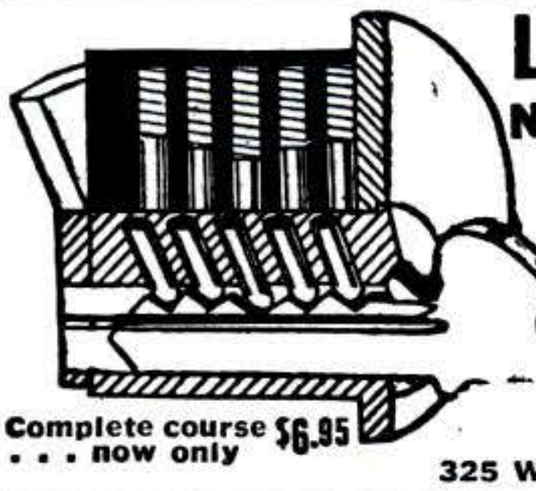

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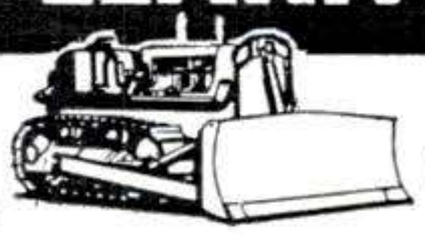

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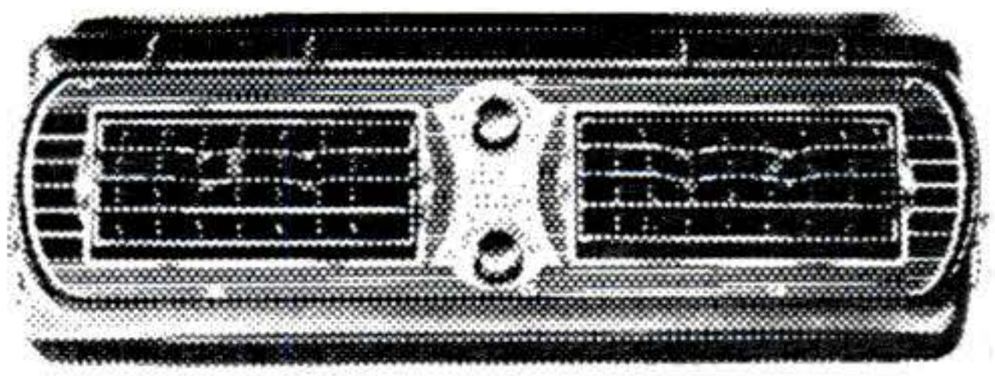

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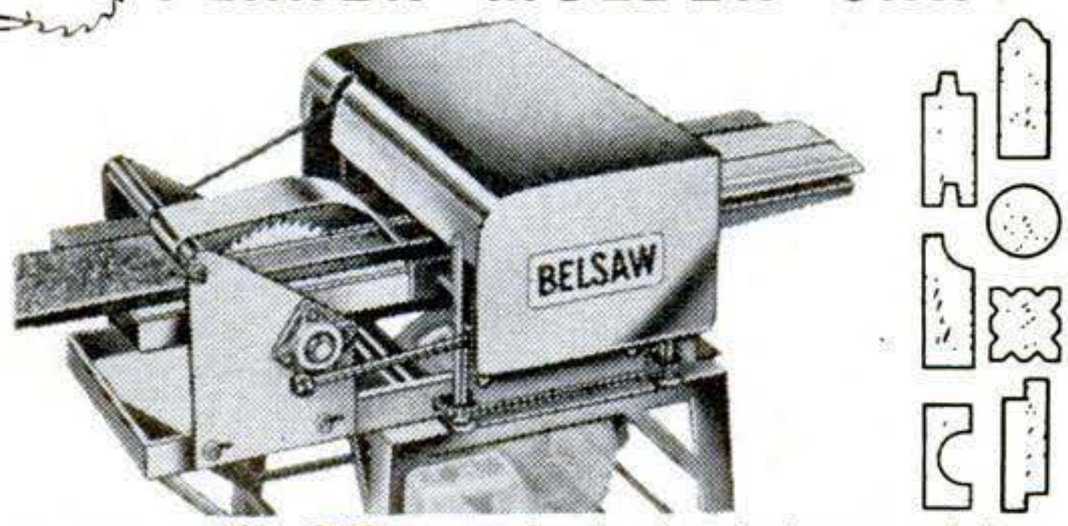

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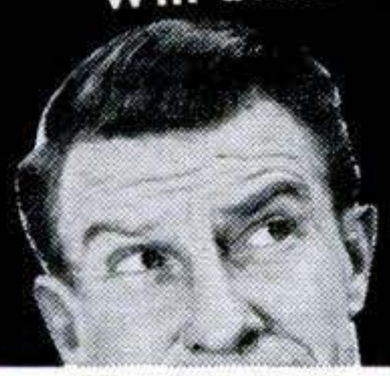

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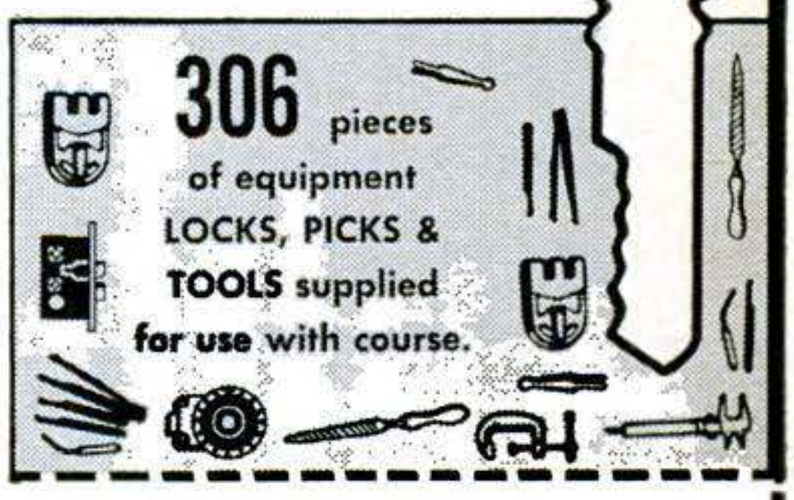

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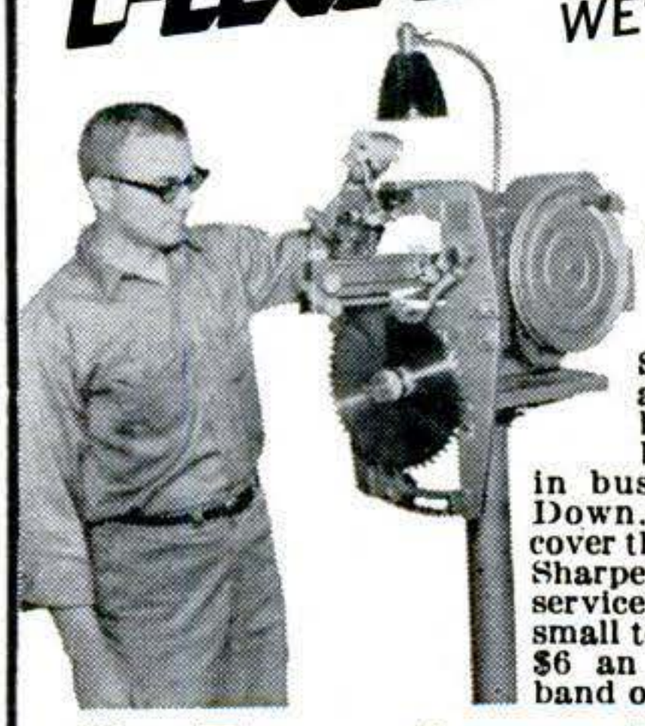

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Detroit Report...

DEVELOPMENT OF ITS MINI-COMPACT PHOENIX is being pushed frantically by Ford in an effort to keep General Motors from getting the inside track in the small-car field with its XP 887, scheduled for production in August, 1970. Ford is doing all in its power to get the Phoenix ready at the same time. Latest word from insiders is that Ford will use a four-cylinder, single-overhead-camshaft engine in the Phoenix. Body design will borrow from Fiat, Opel, and English Ford.

Can GM take the Mustang market away from Ford? Chevrolet and Pontiac are mounting a major assault on the sporty-car field. Both divisions are preparing special 1970½ fastback coupes in the Camaro and Firebird lines. Prototypes show that GM is going all out with styling on these new cars and will sacrifice the rear seats completely to give the cars an exceptionally dramatic fastback look. Firebird styling highlights include:

- Ultra-thin pillars on both sides of the windshield, giving the appearance of no pillars at all.
- No rear side windows.
- Door windows inclined sharply into the roof.
- Extremely large rear window.
- Chopped-off tail, similar to the original Toronado's.

Watch for a four-door Maverick from Ford later in the year (the two-door Maverick will go on sale next month). The four-door version will have a longer wheelbase than the two-door, about 106 inches. This longer Maverick loses most of the sportiness of the two-door body, and looks strikingly like the '69 Falcon four-door sedan. Why the longer wheelbase? Ford had to stretch the whole car, because the original Maverick dimensions just left no room for an extra door on each side. When both Mavericks are on the market, Ford will decide whether to continue the two- and four-door Falcon models or to drop the Falcon altogether.

No plans for a U.S.-built mini-compact at Chrysler, said a Corporation official as late as January, '69. To compete with General Motors' XP 887 and Ford's Phoenix, Chrysler apparently will continue to lean to the idea that the best way to handle small cars in the U.S. is to build them in Europe and export them all over the world. Chrysler is shuffling teams of experts to its European subsidiaries—Rootes in England, Simca in France—to see if an Americanized version of a small car can be built over there. One of the reasons behind Chrysler's "build-in-Europe" policy is the belief that Americans buy imported cars for prestige reasons. With a Simca or a Sunbeam, the customer spends less than he would on a Valiant, yet his neighbors won't sneer at him for buying a cheap car.

The '70 Thunderbird will get a radical facelift to bring its styling more in line with the Pontiac Grand Prix. The new T-bird's front end will be dominated by a pointed centerpiece much like the grille design on the GP. Its headlights will be spaced evenly on each side and will no longer be hidden by covers. The grille has crisscross textured brightwork, and the whole front end looks lighter and more sharply defined than on the '69 model. The Thunderbird's roof line, which has been its trademark since the name first appeared in 1955, will lose its traditional angularity and become more sweeping. Overall dimensions and interior layout of the new car will remain unchanged.

GM will copy Ford's styling formula for its intermediate 1970 models, with optional fastbacks in addition to the regular notchback bodies of the two-door hardtops. The decision to go with a fastback roof is based on the success Ford has enjoyed with its flat-roofed Torino and Montego models. It may also have some basis in Ford's success at the race track. Although GM isn't officially in racing, its intermediates have been running in some stock-car events, and the fastback roof line will reduce aerodynamic drag enough to give the cars an extra three to five m.p.h.

Jim Dunne

Detroit Editor

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Report from Daytona: winners of the 1969 Union/Pure Oil Performance Trials!

NASCAR INTERNATIONAL	Economy (Miles per gal.)	Braking* (panic stop from 65 mph)	Acceleration† (from 25 to 70 mph)
Buick Riviera (Super Deluxe) ..... **won Class 1**	14.902	202.9	8.205
Dodge Monaco (Deluxe 8-cyl.) ..... **won Class 2**	16.149	202.8	8.675
Dodge Polara (Medium 8-cyl.) ..... **won Class 3**	18.589	193.3	11.805
Chevrolet Impala (Popular 8-cyl.) ..... **won Class 4**	16.791	195.6	9.915
Plymouth Fury I (Standard 8-cyl.) ..... **won Class 5**	18.482	200.5	11.755
Ford Fairlane 500 (Intermediate 8-cyl.) ..... **won Class 6**	19.823	189.1	10.80
Plymouth Valiant Signet (Compact 6-cyl.) ... **won Class 7**	23.170	192.8	15.30
Dodge Charger R/T (Sport Intermediate) ..... **won Class 8**	14.939	190.4	5.565
Plymouth Barracuda (Sport Compact) ..... **won Class 9**	19.897	194.6	10.03

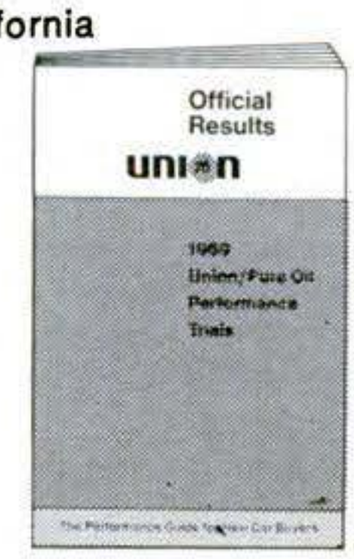
* in feet † in seconds

9 Class-Champions of the toughest public test ever! The 12th Annual Union/Pure Oil Performance Trials give you more answers to questions about more new cars than ever before. Answers you can't get anywhere else. Like, what mileage did they get? How good were their brakes? Which cars showed the best acceleration? And, how do the nine Class-Champions compare with others in their class?

Check the overall class-winners here. And get the Official Results Handbook—with complete data on the final standings of all 60 models entered—free, from your Pure Oil or Union 76 dealer. Or write to one of the following:

Performance Trials, Dept. PS-39
Union Oil Company
of California
P.O. Box 830
Fullerton, Calif. 92638

Performance Trials, Dept. PS-39
Pure Oil Division
Union Oil Company of California
200 East Golf Road
Palatine, Illinois 60067



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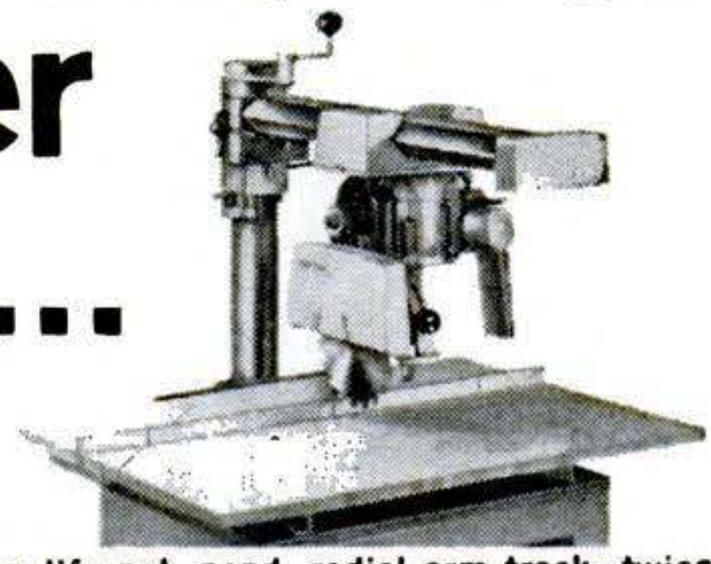

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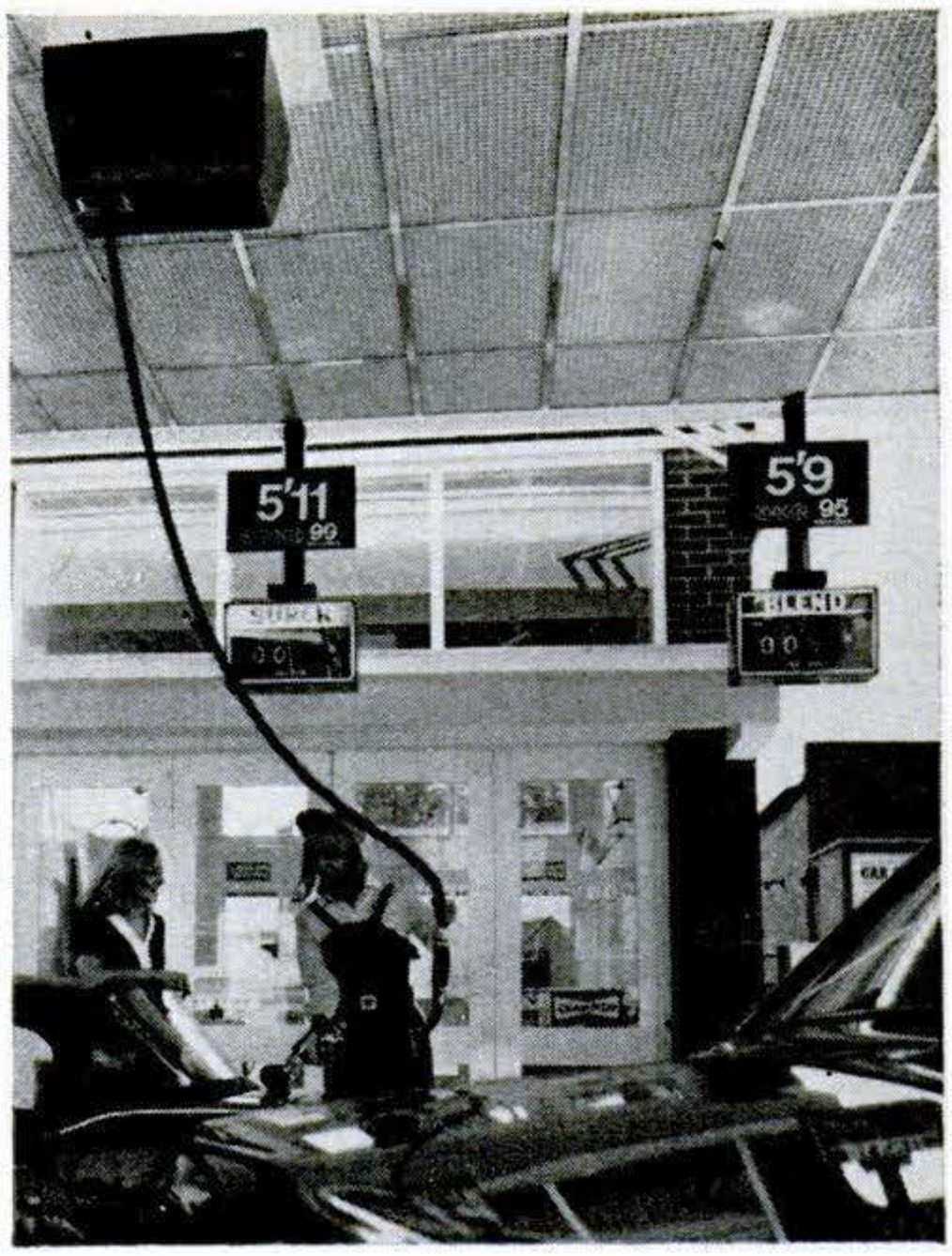

These gas pumps are hung-up

A gas station in Birmingham, England, saves time and space with reeled hoses hung from a canopy over the fueling area. Pressing a button lowers the right hose; pulling the nozzle starts the pumps. The gallons pumped are metered overhead.

Oil tank flies on air

With a hovercraft skirt fitted to its 50-foot-diameter base, this 70-ton oil-storage tank floated on a 10-inch air cushion to an Esso ocean terminal in England. A 130-hp. diesel on a trailer ran its fans; and with a truck winching it ahead, the tank traveled far faster than if moved by inching it along with jacks and rollers.

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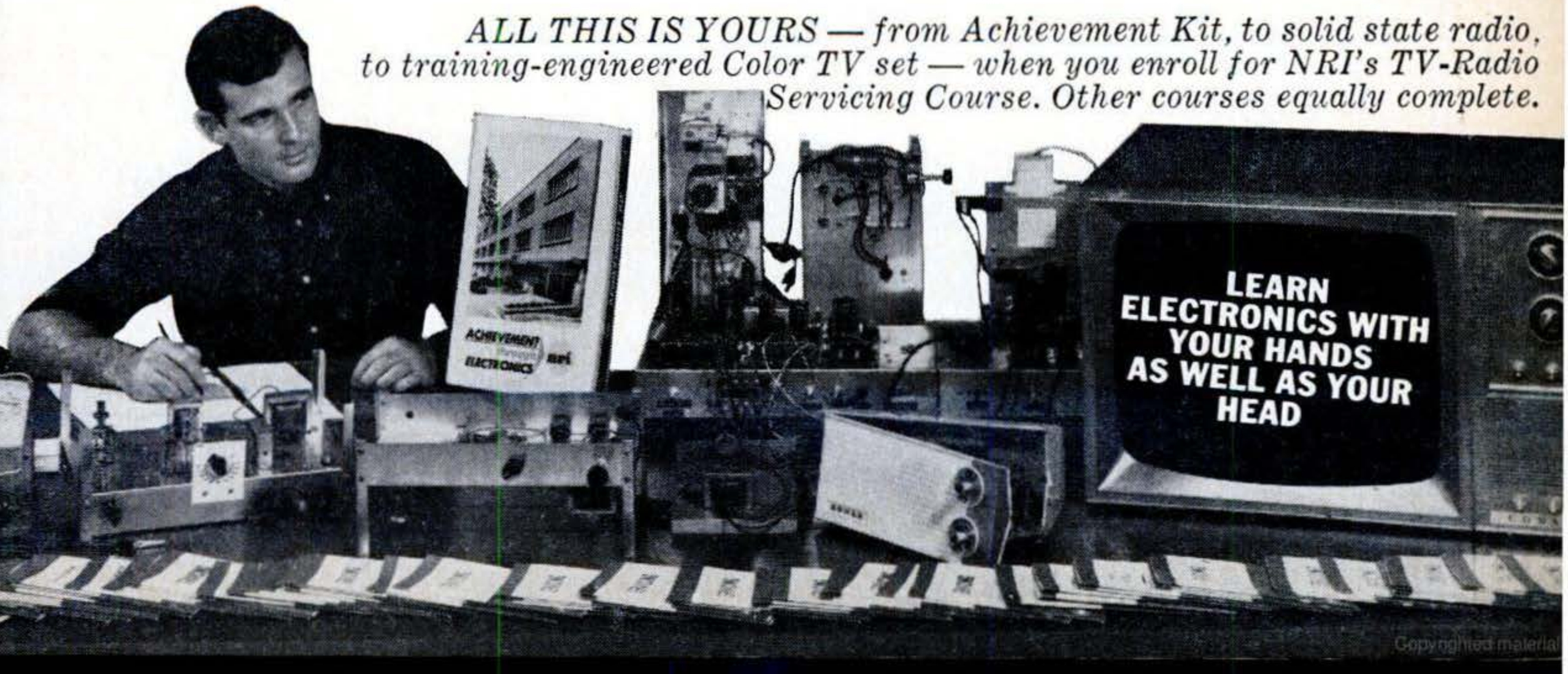

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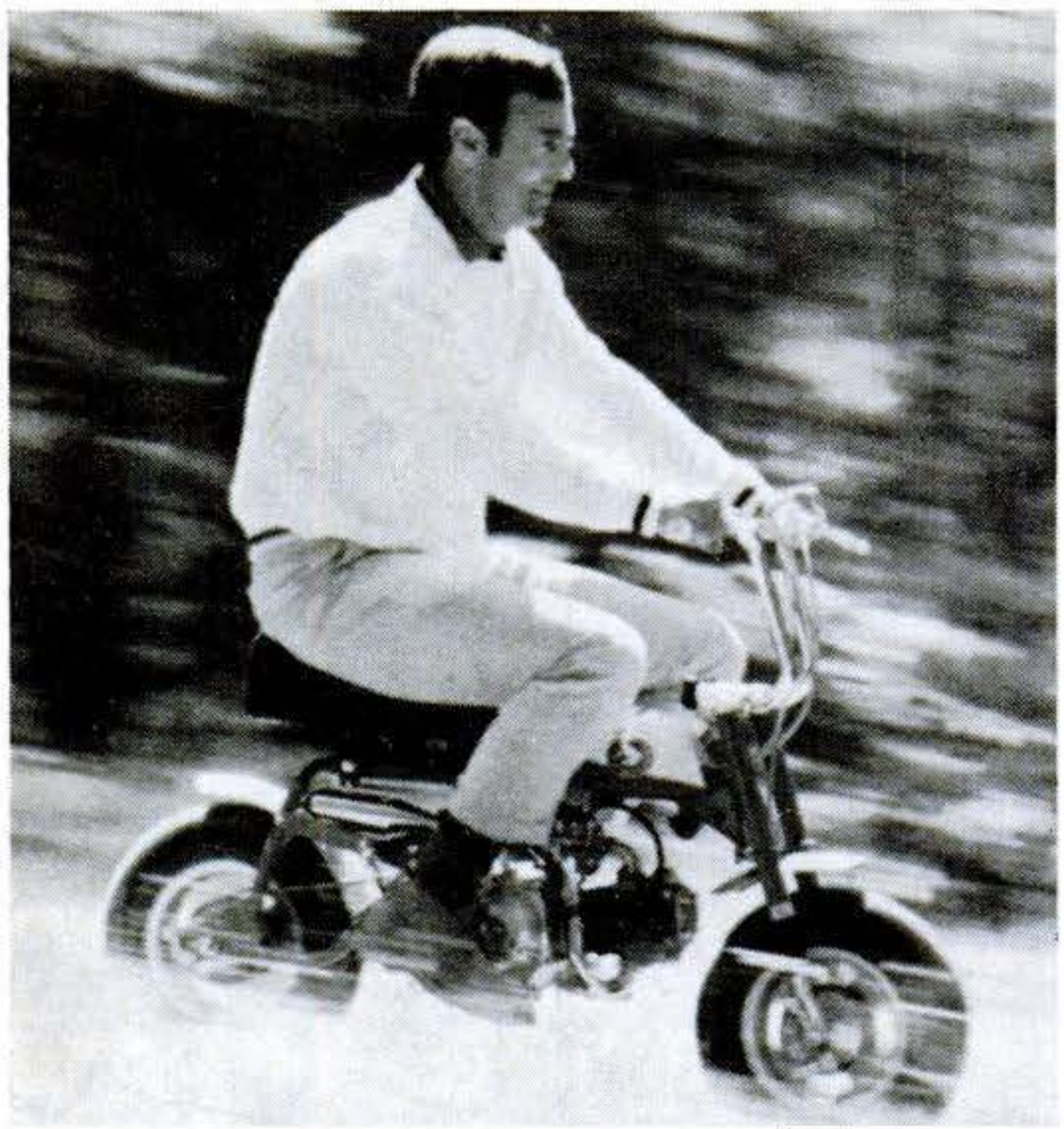
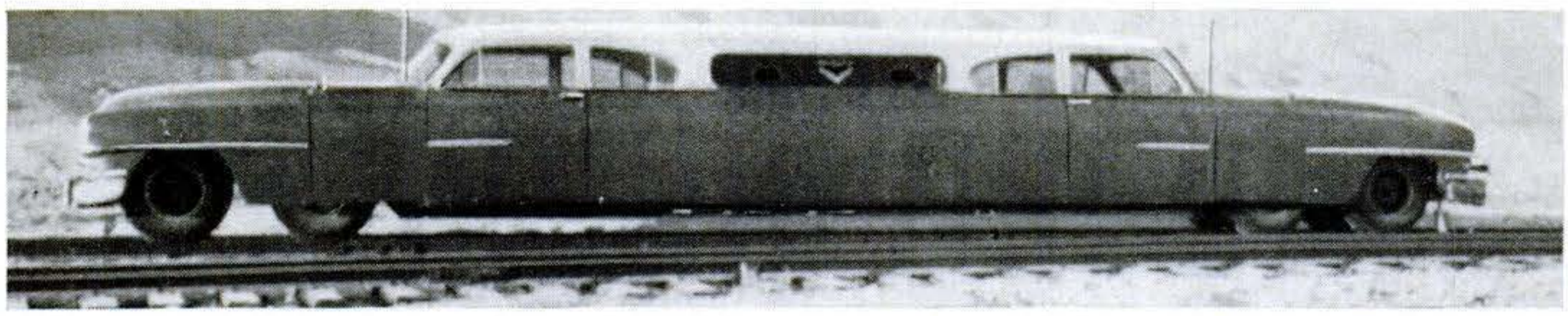


Smallest Honda hits the trail

Joining the midget-bike field is this new Mini Trail, a 108-pound off-road cycle. Powered by a new overhead-cam 50cc four-stroke engine, it has three-speed gearbox with automatic clutch, knobby tires, and telescopic front fork. Fold-down handlebars make it possible for it to be carried in a car.

Escape chute turns into life raft

Bottled compressed air inflates this British chute five seconds after it's dropped from the door of a plane. After passengers have slid down, the chute is released, lacings (which hold longitudinal and lateral stiffening tubes in place) are cut, and the tubes roll out, forming a fabric-bottomed raft.



Desert rail car has two heads

The Blue Goose, a twin 1953 Chrysler-bodied rail car with a midships 160-hp. engine, carries U.S. Gypsum Co. maintenance crews from the quarry to the Plaster City, Calif., plant, 26 miles across the desert. The 6,000-pound double-header has eight steel-cord tires with guide flanges on inside hubs. It can run in either direction, hits 40 m.p.h.

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Be a loop charger! Johnson's loop-charged 3-cyl 55 gives a new twist to fuel induction...lets you out-pull, out-run, out-troll comparable hp motors—all on less fuel than you'd expect.

In loop charging, the fuel charge is swirled directly into the domed combustion chamber through precisely angled intake ports to produce combustion efficiency far superior to previous methods. Makes the most of every drop of fuel. Gearcase, gear ratios and prop diameters are computer-selected to turn big power into even bigger thrust.

Patented Water-Shield Silencing makes it extra quiet...Hydro-Electric power shift is extra sure, extra easy.

Feels like more than 55 horsepower but doesn't sound like it—patented Water-Shield silencing encases (and cools) the exhaust housing in a sound-absorbing water chamber while a unique isolation system tones out vibration. New Hydro-Electric drive is boating's most advanced, dependable single lever shift.

See this super-duper looper at your Johnson dealer's...one of 16 new or improved Sea-Horse models. All with 2-yr. warranty.*

See the 55 and the rest of the Sea-Horse line (1½ to 115 hp). Your dealer is in the Yellow Pages. Or write direct for free 36-page catalog. Johnson Motors, Waukegan, Ill. 60085, Dept. PS-93

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Little Tank Works Big Wonders

This little tank and the parts that go with it are known as a Coolant Recovery System (CRS). To start with, it prevents loss of coolant. In installing the kit, you cut off the overflow pipe and hook up a plastic hose that feeds into the tank. The new pressure cap has a double seal, so when the engine cools off, coolant is drawn back into the radiator from the tank.

The system keeps the radiator and its tanks completely filled with coolant. The absence of air prevents foaming, a major cause of overheating. I have seen service reports from car companies where overheating complaints were permanently cured by fitting the CRS. Cadillac standardized this type of sealed cooling for its 1969 models. Fiat, Renault, and many other European cars use it as original equipment.

Why is air in the system so bad? Once the water pump begins to pump air, the coolant flow turns into a turbulent stream of bubbles and foam. The radiator's capacity is used up cooling this useless mixture, while the coolant continues to build up heat inside the engine. Soon, the water pump is pumping steam, which then goes right out the overflow pipe.

With the CRS fitted on your car, the coolant flow is entirely liquid, and the radiator works as intended.

Other advantages: Absence of air in the system cuts oxidation while increasing the life of the radiator and heater hoses. Servicing is eliminated, and you need never remove the radiator cap. Installation is easy and takes you about 20 minutes. Cost of the kit is under $10 from J. C. Penney.—*Jan P. Norbye.*

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This $100,000 car was built to break the world land speed record. They didn't scrimp on anything. They used Autolite spark plugs. Like you buy. About $1 each.

This wheeled projectile is 30 feet long and 37 inches high. It looks a lot like a bullet. And it goes like one, too. On one of the early runs it topped 400 miles per hour easily. And it was just warming up then.

It has two 427-SOHC Ford engines. A conventionally aspirated one producing 810 horses up front. And a supercharged one producing 1260 horses in the rear. These engines cost over $6,000 apiece.

The spark plugs? They're Autolite plugs. Like you buy for about a dollar each.

Autolite plugs are specially constructed to keep performing at the highest peak regardless of how rough the going gets. The hermetic glass seal is designed to stay intact despite extremes in heat, pressure, or stress. That means that compression can't leak off just when you need it most.

Why such low-priced spark plugs in a $100,000 car? Because there are no better plugs. Not at any price. So put Autolite spark plugs in your car. Whatever kind of car you drive.

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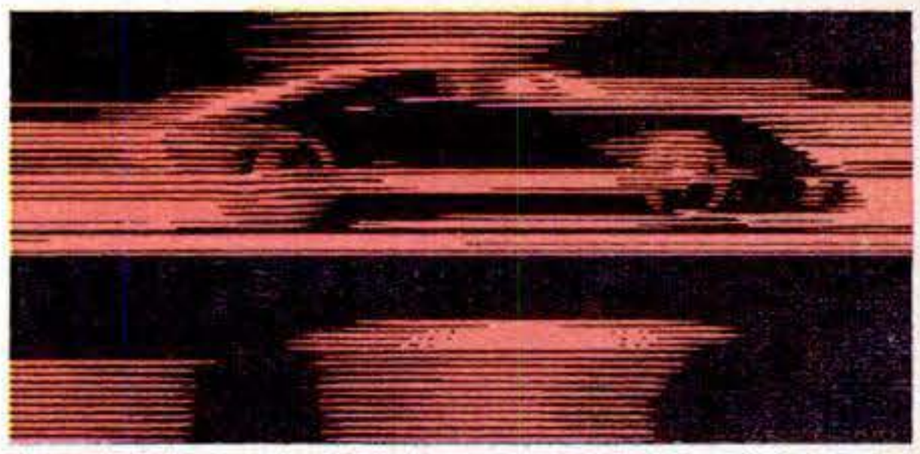
Autolite Ford



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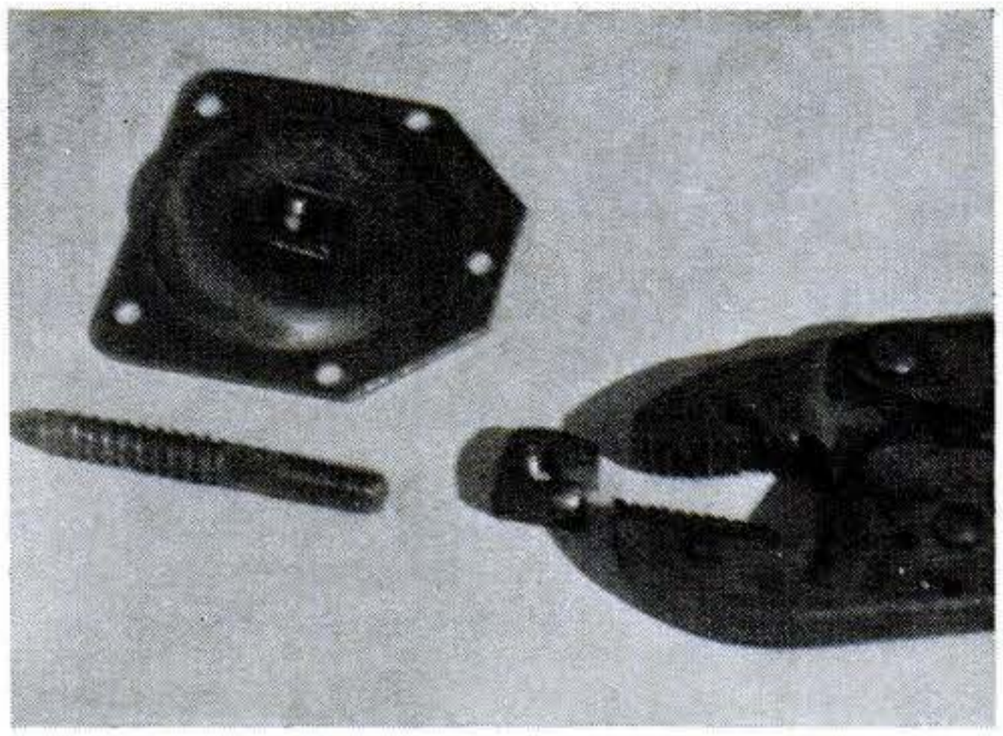
Golf tees make small feet

Plastic tees make colorful and sturdy feet for trivets and other small items. Bore holes slightly smaller than the tee-stem diameter in the object you're mounting, and cut the tees to a length that will give the item the desired lift.

WALTER BURTON, Akron, Ohio.



Save hanger bolts with a clamp nut

Cut out a narrow slot at one side of a nut with a hacksaw, and you can turn hanger bolts into a table leg without damaging the machine threads with a wrench or pliers. Thread the altered nut over the bolt. Gripped in a vise or in locking pliers, it will hold the bolt securely so that it can't turn.

R. S. TUPPER, Canton, S.D.

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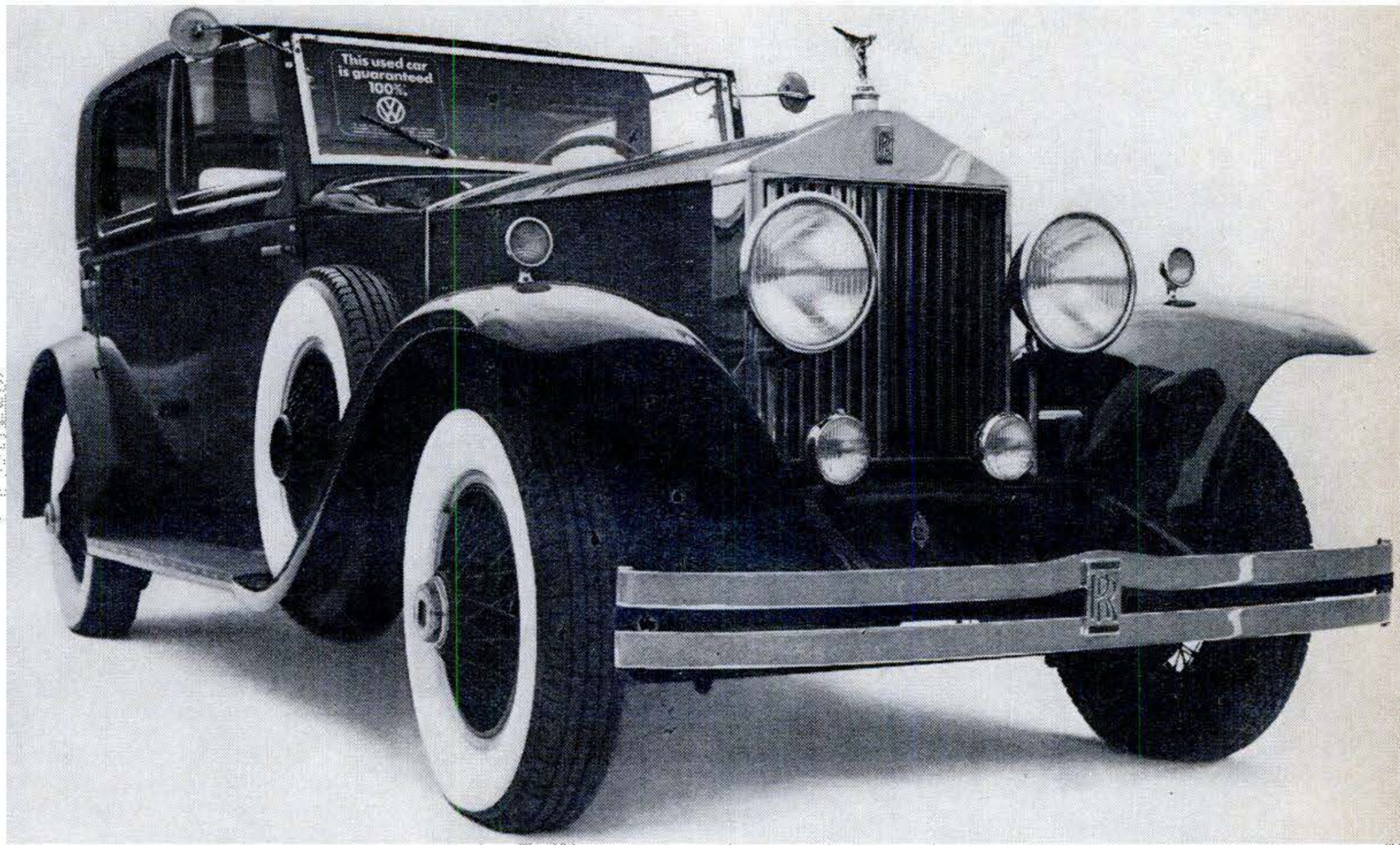

Pick up a good second car from Volkswagen.

Somebody traded in a Rolls-Royce for a Volkswagen?

Yes, somebody traded in a Rolls-Royce for a Volkswagen.

It happened in Texas, of course.

But even in average states some pretty fancy cars show up on a VW dealer's used car lot.

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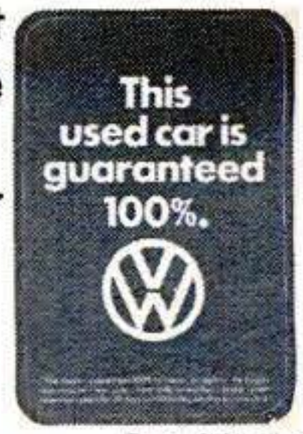
Whichever comes first.

So when a Volkswagen dealer says that a used car is as good on the inside as it looks on the outside, you don't have to trust him.

He'll put it all down in writing for you.



*engine, transmission, rear axle, front axle assemblies, brake system, electrical system.

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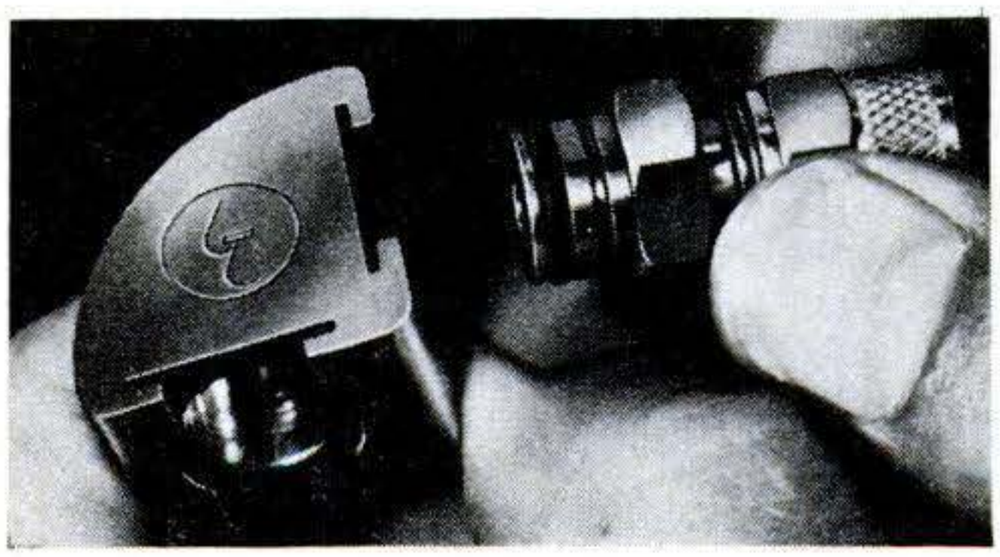
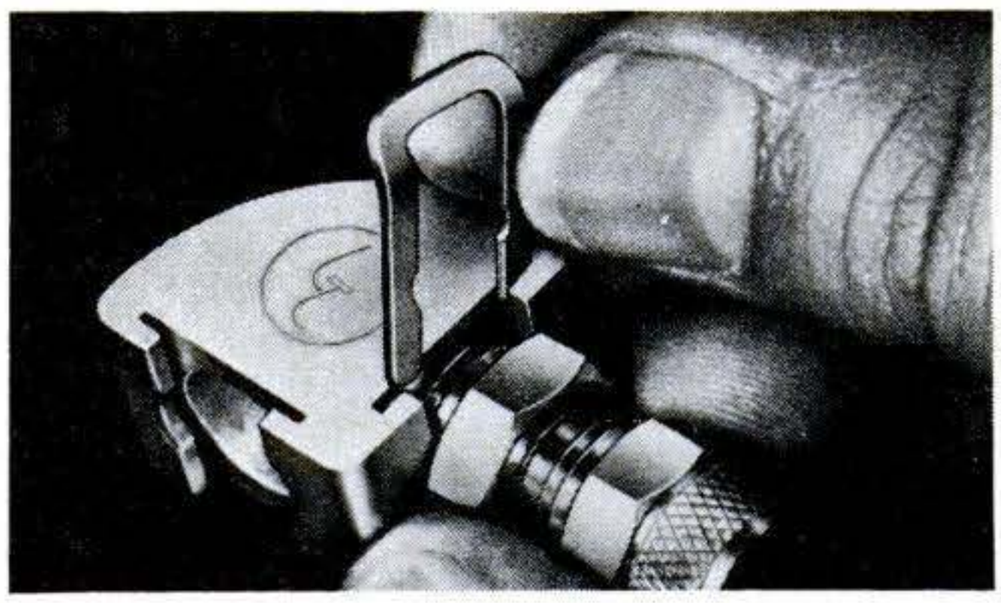
No-Wrench Fittings Snap Together

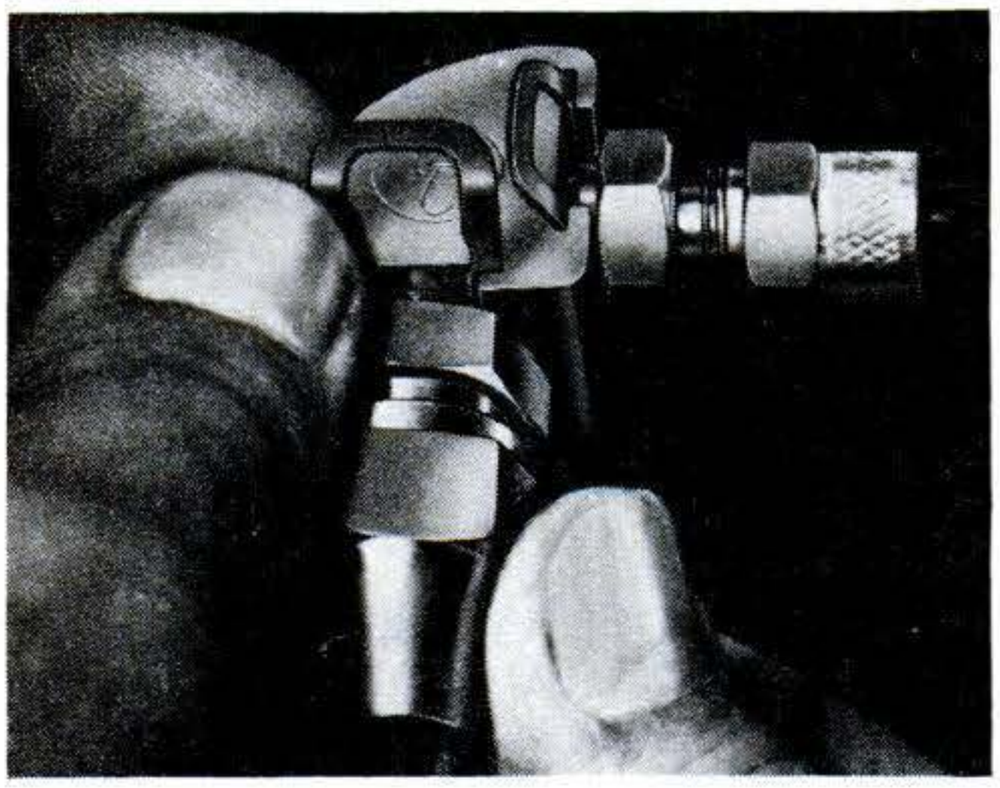
Here's a new kind of fitting . . . that locks together with a clip and is more compact than conventional fittings. No crossed threads—no tools needed. Gra-Tec, Inc., 252 State St., Los Altos, Calif., makes it of plastic and of metal in shapes and sizes to suit many jobs. For winter sportsmen, a snowmobile fuel filter, from Polar Fuel Filters, Minneapolis, Minn., uses these fittings, so you can remove and de-ice filter and lines on the coldest day.



Fitting with O ring slips into connector . . .



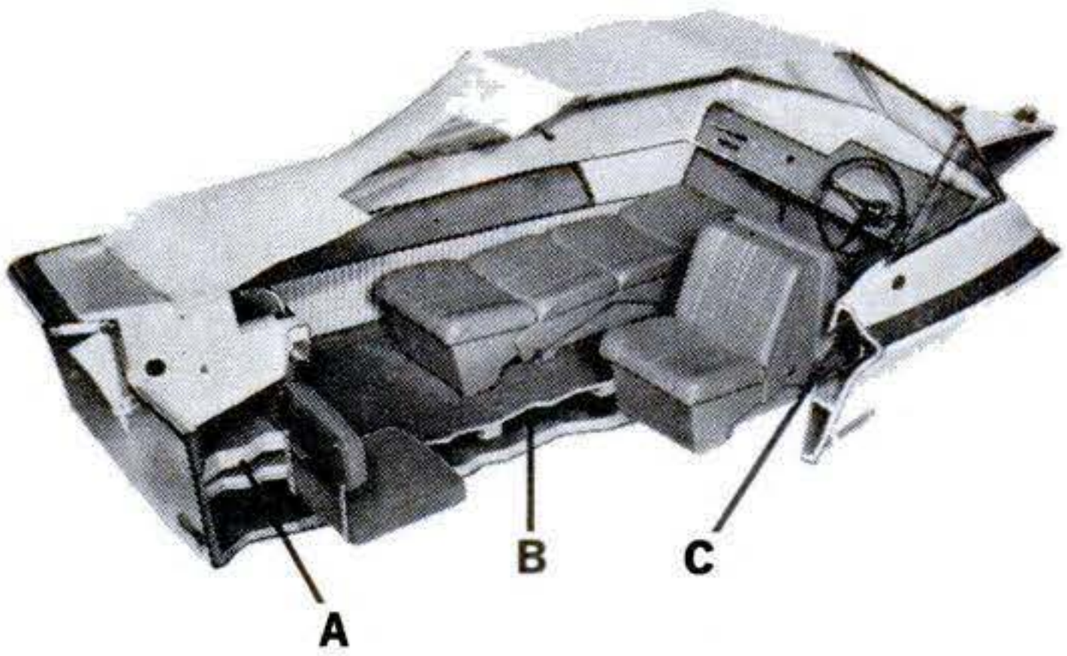
Retainer clip snaps components together . . .



Elbow joint is assembled in 10 seconds.

Life/Guard Construction

. . . the most important development since fibreglass



A. Foam is high in sides, under gunwale and deck, so buoyancy is high in hull.

B. Bilge tunnel fills with water if boat fills. Counteracts buoyancy of bottom so boat floats upright, even if filled with water.

C. Life/Guard construction makes flotation foam an integral part of hull: fibreglass — foam —fibreglass. Safer, stronger, quieter than conventional hulls.

In most hulls, flotation is provided by blocks of plastic foam and by an air chamber in the bottom. Some types of foam can become waterlogged and ineffective. And because most buoyancy is in the bottom, a boat filled with water tends to capsize.

Here's how Life/Guard Construction is different: a new kind of foaming plastic becomes an integral part of the boat. It soaks up sound and vibration but can't soak up water.

It's safer because the foaming plastic can't become waterlogged and because flotation is high in the hull. This fact, combined with the "bilge tunnel" makes it virtually impossible for a boat filled with water to "belly up"—it remains right side up.

It's stronger because the Life/Guard hull is an integrated unit of fibreglass, foam which adds structural strength, and additional layers of fibreglass.

It's quieter because the foam deadens water and engine noise instead of amplifying it.

Larson®

LARSON INDUSTRIES, INC.
2325 Endicott Street, St. Paul Minnesota 55114
*Patent Applied for

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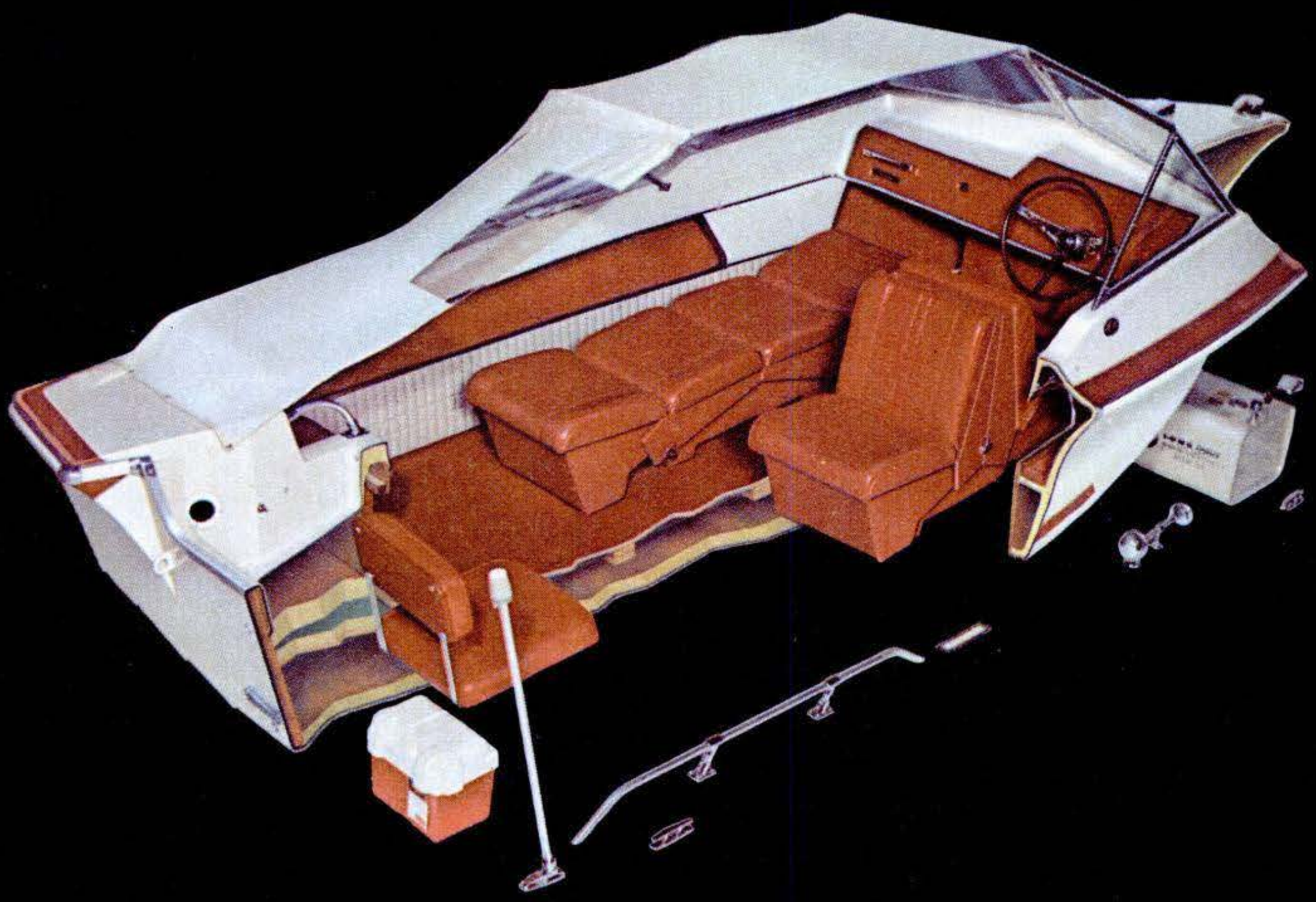

The unextras

(and Life/Guard is the biggest unextra of all)

In a lot of boats, they're *extras*. In Larson, *unextras*. And yet, Larsons usually cost no more than boats without them.

Here are some of the typical Larson unextras: Top set including side curtains and stern cover, sunbather seats, a built in gas tank with dash mounted gas gauge, mechanical steering, and a safety glass windshield.

The reason we can afford to be so generous is that Larsons are built efficiently. We make almost everything but the engines... in plants that make more fibreglass runabouts than any other plants.

Our Million Bubble Ride is another unextra ... one you can't buy in other boats at any price. Larson's exclusive Lapline design builds an air cushion under the hull that reduces drag and softens the ride.

New Life/Guard Construction* is another reason to make your new boat a Larson. It's a whole new way of building boats that makes flotation do more than ever before. It's part of the hull. Adds strength. Puts the flotation high in the hull, where it belongs. Absorbs sound. Dulls crashing waves.

Get all the facts now by visiting your Larson dealer. Be a smart shopper. Larson loves comparison.

Patent Applied for.

Larson®

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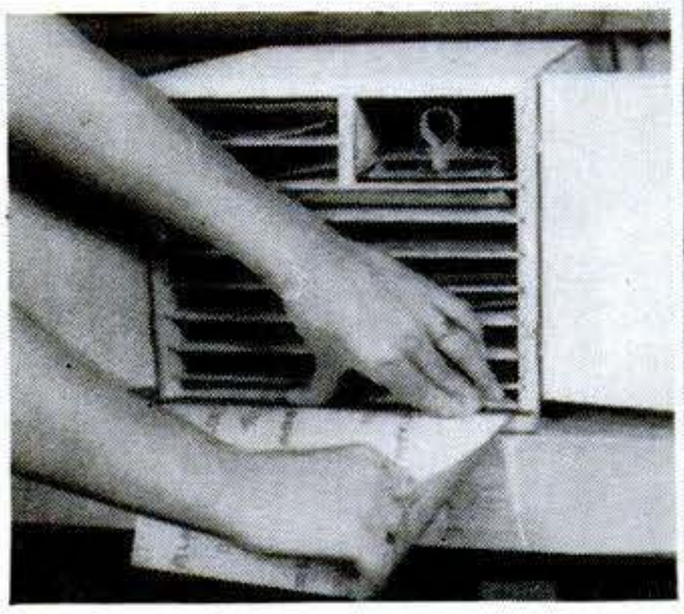
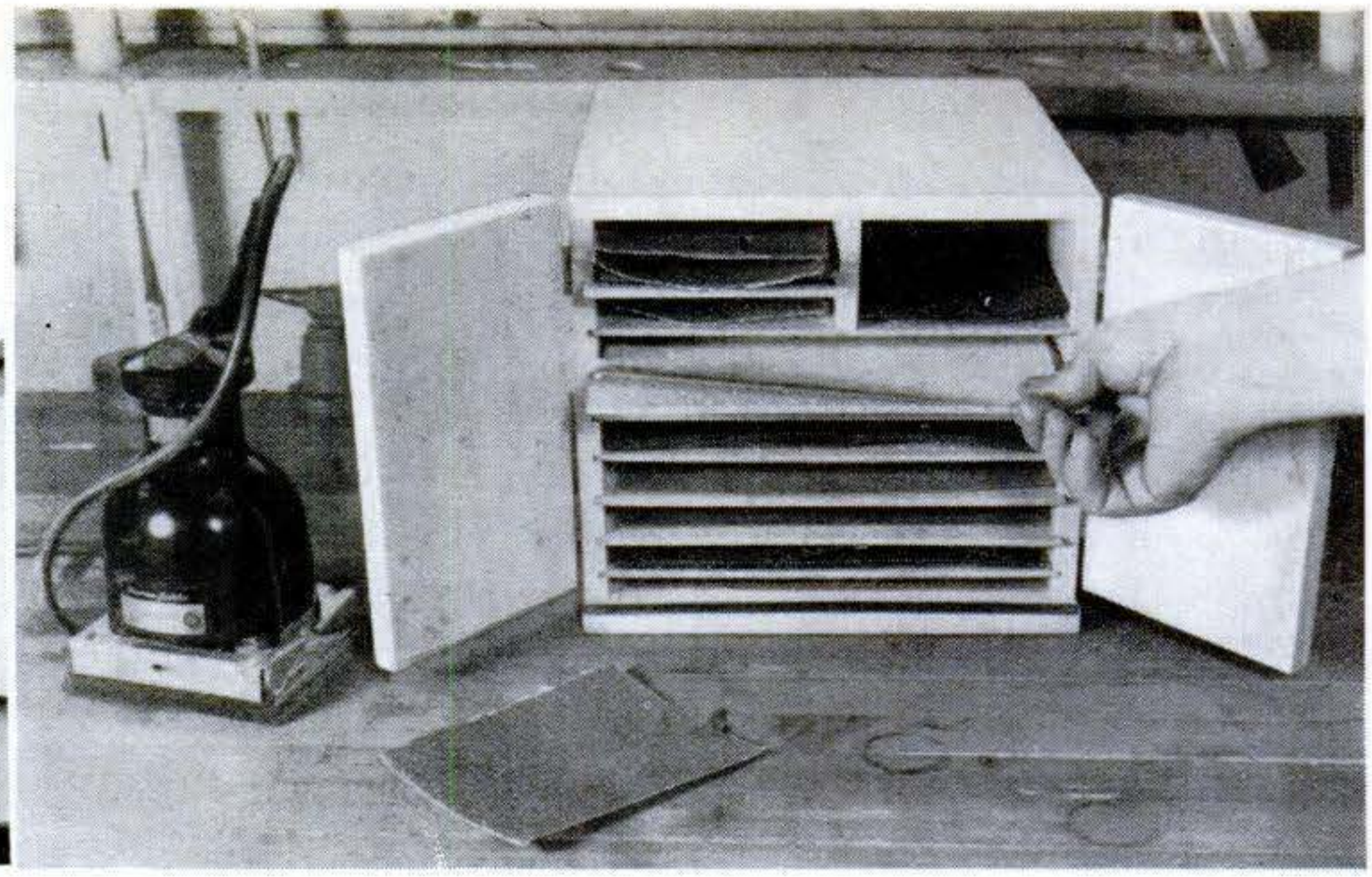
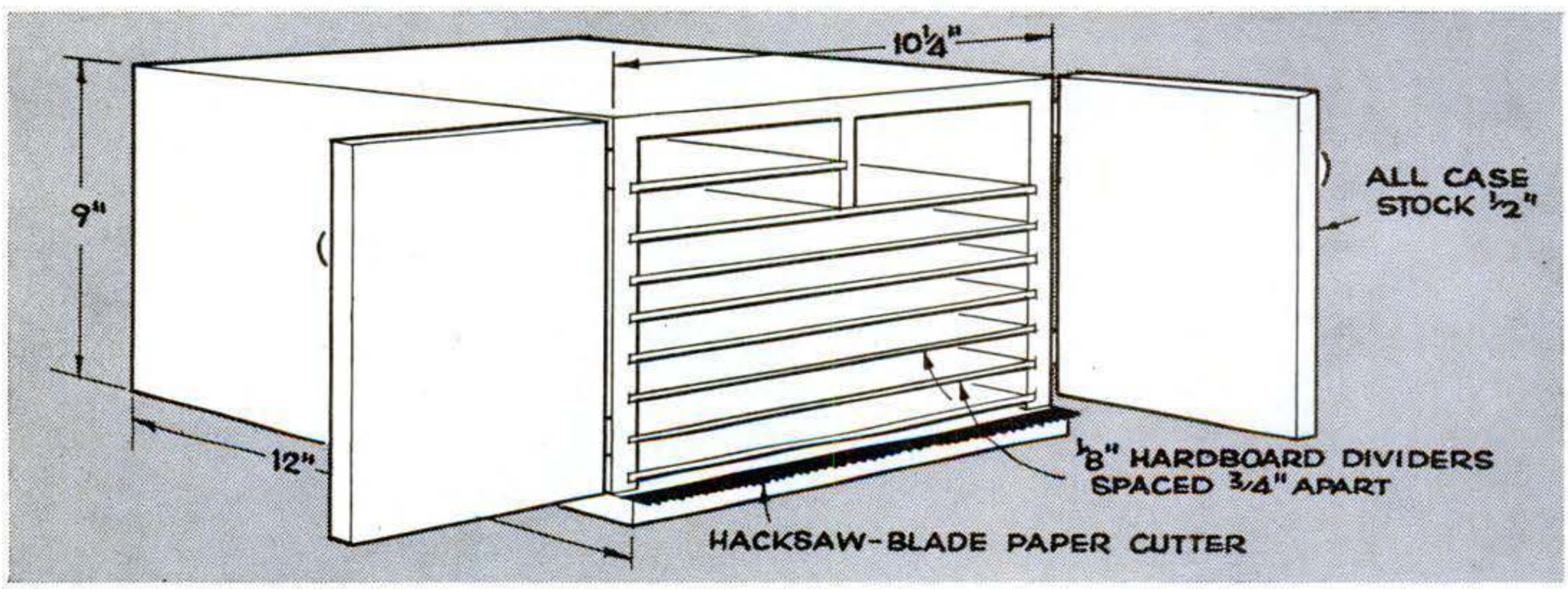
SHORT CUTS AND TIPS

FROM HERE AND THERE



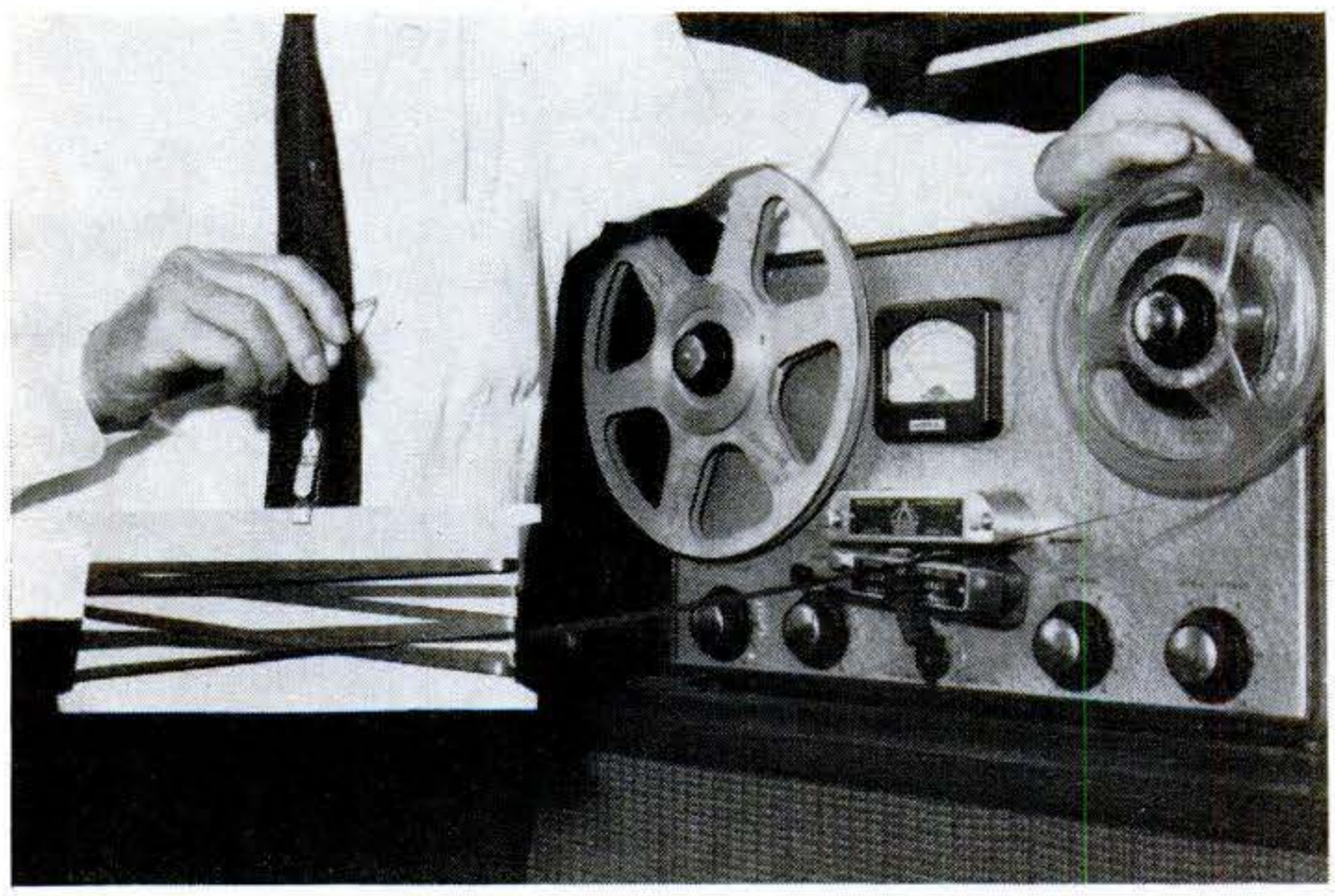




Easy-to-make chest stores and cuts your supply of sandpaper

Sliding shelves make for easy selection of sandpaper from this storage chest. Make the case from ½" pine, if available, or ½" plywood. Use ⅛" hardboard for the shelves. Make sure that you cut the grooves wide enough so that the hardboard shelves slide smoothly. The compartment at the upper right is designed for a sanding block. This shelf is fixed. The cutter lets you make half and quarter sheets for use in sanding blocks or power sanders. It is a hacksaw blade screwed to the bottom of the case at the front edge, raised slightly with washers so that you can slide sandpaper under it. The blade is then pressed down, the paper torn upwards.

C. WAYNE CLOSE, Grants Pass, Ore.



Handy way to mail tape

If you like to communicate by recording tape, you can save postage with this trick: Mail the tape in a regular large-size envelope by reeling it around a piece of cardboard, cut to the size and shape shown at far left in the photo.

Use a polyester tape; it will stand up to rough treatment in transit. It's wise, too, to label the envelope "magnetic tape" to prevent danger of erasure.

HAROLD KING,
N. Hollywood, Calif.

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The Evinrude Triumph is unfair

Triumph's aimed intake passages "loop" the fuel charge up and away from the exhaust ports. Deflectors and all their problems are eliminated. Note the flat-top automotive-type pistons, the fuel passages molded into the cast iron cylinder sleeves, the fuel delivery "window" in the piston skirt, and the efficiently shaped hemispherical combustion chamber.

It has a built-in $5,000,000 advantage.

The advantage is "loop charging"-a new, dramatically more efficient way of fueling a modern outboard engine.

Loop charging delivers an *aimed* fuel charge *directly* to the top of the combustion dome. It eliminates need for the deflector "hump" on the piston and the deflector-shaped "bulge" in the combustion chamber.

With the deflector gone, pistons are lighter, compression can be higher, and the combustion chamber can be shaped the way it ought to be shaped.

The loop principle isn't new. But because of the problems of building precision fuel passages into the spaces between cylinders — it has never before been possible to build a true loop system into a modern water-cooled multi-cylinder aluminum outboard engine.

A year ago, Evinrude engineering broke through the design barrier.

The method was ingenious (see diagram), and the results were spectacular. One result of our $5,000,000 research and tooling investment was an immediate saving of as much as a gallon of fuel an hour in the top speed range (where fuel savings really count).

Fuel economy is exceptional. But so is performance. The Triumph "55" actually equals our workhorse "65" in pulling power, and surpasses it in speed and quiet and push-button elegance. The Evinrude "55" *eliminated* the Evinrude "65".

We hadn't planned on being quite that unfair.

CATALOG FREE, Write Evinrude Motors, 4281 N. 27th St., Milwaukee, Wis. 53216

EVINRUDE
Div. of Outboard Marine Corporation

first in outboards

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Taste the golden age of Schlitz

120 years ago, it took Joseph Schlitz months to brew and age the first golden mellow drop of Schlitz. It still takes us months to brew and age Schlitz. The long, careful, golden age of Schlitz is what makes it America's choicest premium beer. Once you taste our golden age, you'll know why we say:

"When you're out of Schlitz, you're out of beer."

Schlitz®

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Popular Science
REG. U.S. PAT. OFF. MONTHLY

Boon Docker buggies are offered in several highly individual body styles, from imitation Kübelwagen to phony antique. The plastic hardtop is removable. Prices run $245 to $2,995 depending on equipment.

The growing rage for FUN CARS

It all began with an old Volkswagen chassis and a fiberglass body. Now you have a choice of about 50 models of dune buggies

By V. LEE OERTLE

What's been happening in dune buggies? A new fun-car industry has burgeoned almost overnight. When only two short years ago PS ran a report on dune buggies, the roster covered only three of four brands. Today, it includes nearly 40 companies and is growing rapidly. And there are big changes in the wind. You may not long recognize the old familiar product. Six months' work in a special field survey revealed the following trends:

The theme changes. Some of the largest buggy producers flatly predict a switch from off-road to on-street emphasis. This process is already in motion according to expert observers.

"Putting it simply," as Chuck Tatum of Empi Products explains it, "a dune buggy is a lot

Continued

Road Runner has a distinctively rakish appearance. Head-on view shows off bulbous fenders and simulated sports-car radiator.

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Charging through gullies and over hummocks makes exciting sport, but you don't have to go in for

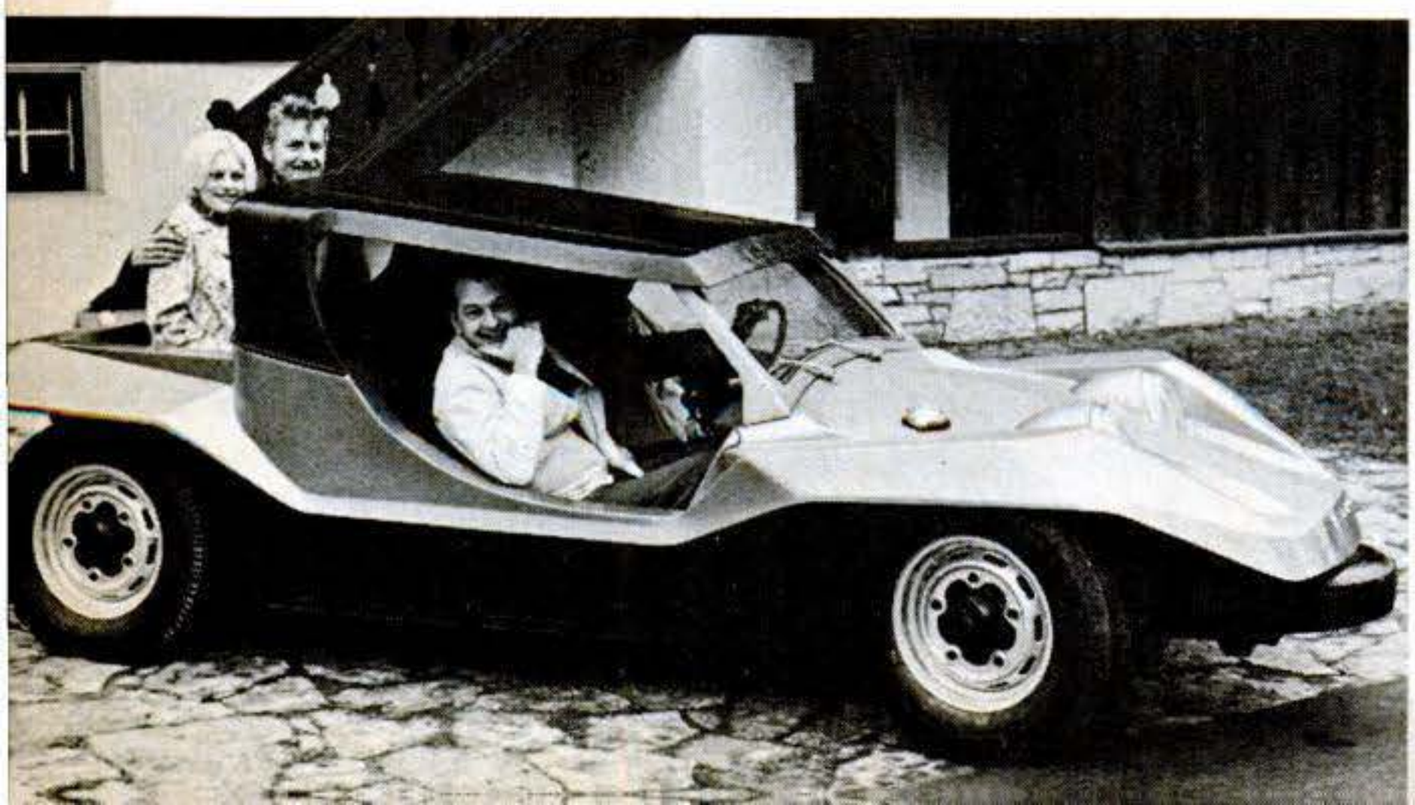
easier to sell the little wife if it has second-car appeal. Obviously, it *does* have such appeal. Excellent gas mileage and incredible tire life are acknowledged. Cut-down VW dune buggies are so supershort you can park one in a space adequate for a large motorcycle. Top that off with the lowest initial price for a second car, and you have a winner."

A great division between off-road and on-street machines will become apparent during 1969:

- There will be more hardtops. Following that trend, complete weather-sealing will make cabs more pleasant in bad weather and extend useful work periods to 12 months of the year.
- The off-road machine will get still wider wheels and tires, higher horsepower, as well as improved rough-road options.
- The on-street buggies will be dressed up. The 1969 Empi Imp, for example, will switch from rayon to nylon floor carpeting. Built-in bucket seats, with a console extending through to the rear-seat area will be part of that company's new-model plans.
- Suspension systems will be tailored to either on-road or off-street duty, depending on what the buyer requires.

Greater variety in bodies is definitely on the way. Presently, the roadster-type dune-buggy bodies are most numerous. Other new body types you can expect this season include miniature Model Ts, half-pickups, tiny station wagons, supercompact camper-coaches, and tub-like bodies resembling the popular old touring sedans. There will even be bodyless frames.

Pizazz is descriptive name of this sleek little dune buggy. Dickey seat behind the crazy, chopped-short hardtop roof tucks in two more jolly riders.



For a hot-rod look, Jeffries Kyote uses magnesium bolt-on wheels and gas-tank cap of race-car type. Recessed headlight treatment is neat styling trick.

acing. Many use fun cars just for trips into mountain and desert where ordinary cars won't go.

The trend toward *complete* road-ready dune buggies is already firmly established. Says one producer: "We're reaching the doctor-lawyer-professional types now. They have more money and less time than the average buggy buyer and want buggies ready to roll with only very simple assembly or finishing needed. Prices will be higher for that sort of buggy, but those people don't mind paying it."

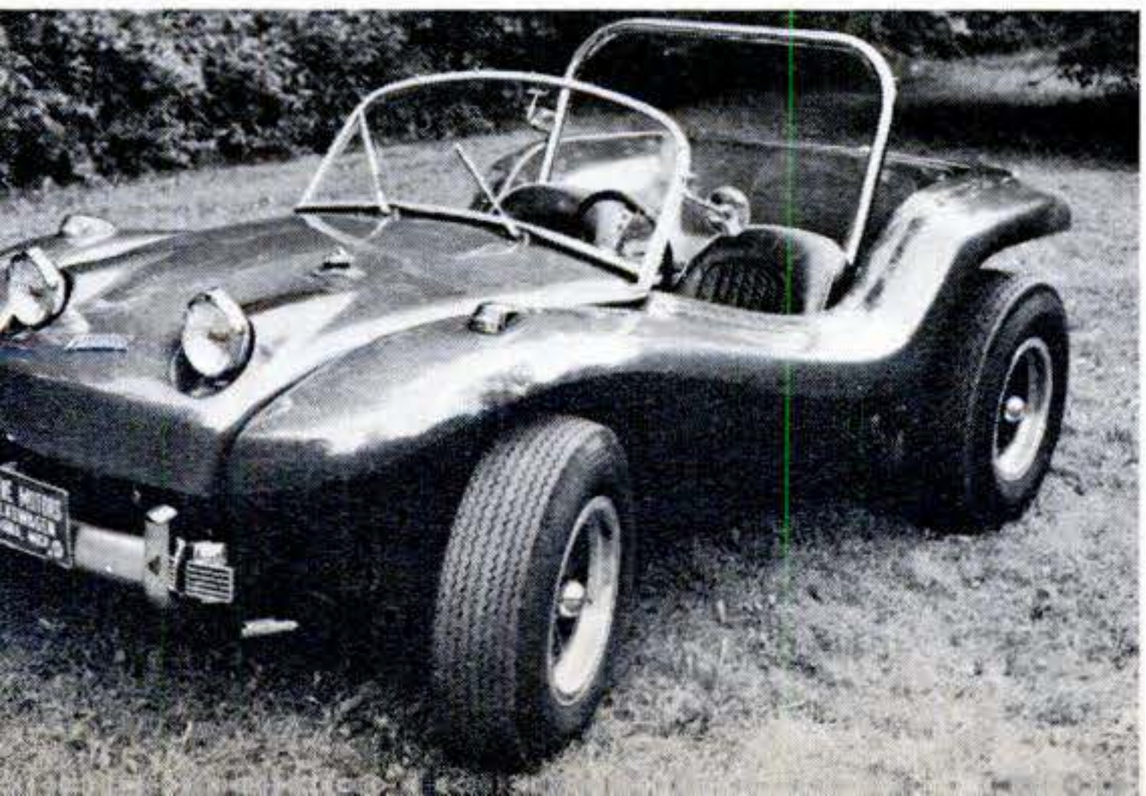
Optional equipment is leaping. One dune-buggy manufacturer now lists over 200 optional accessories. The most popular list includes windshield frames, rollbars, hard tops, soft tops, special bumpers for front or rear, custom seats, suspension-system components, special wheels, and various types and sizes of headlamps.

This coming season you can expect to find more comfort options than ever before. With the accent changing to street usage, some concessions to female drivers will be forced upon us. The biggest hurdle yet remaining is "the entry problem." The gals don't like rolling in and out over those no-door sides. Don't be surprised to see some buggy bodies made with dip-down sides or even tiny side doors. When hard tops are used on the buggies, the entry problem comes into sharper focus because of the restricted distance between top and sides.

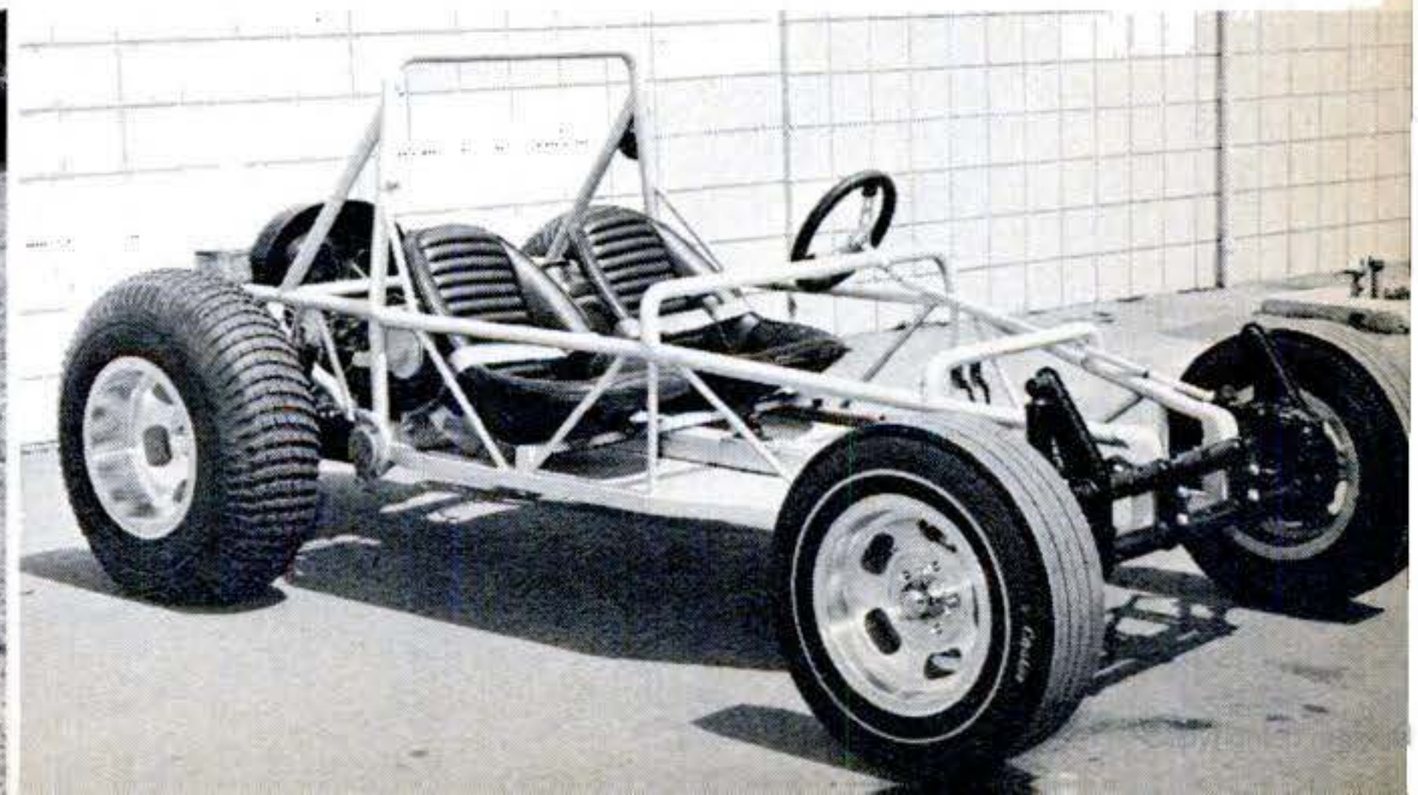
Something for every budget. Prices, never much of an obstacle in this field, fluctuate wildly this season. Part of the reason is that great increase in the number of buggy builders (some estimates go as high as 85 manufacturers, but if there are that

[Continued on page 208]

Minibug, fitted with regular highway tires, has an all-purpose look about it. Optional soft top clips to windshield frame, roll bar, and body sides.

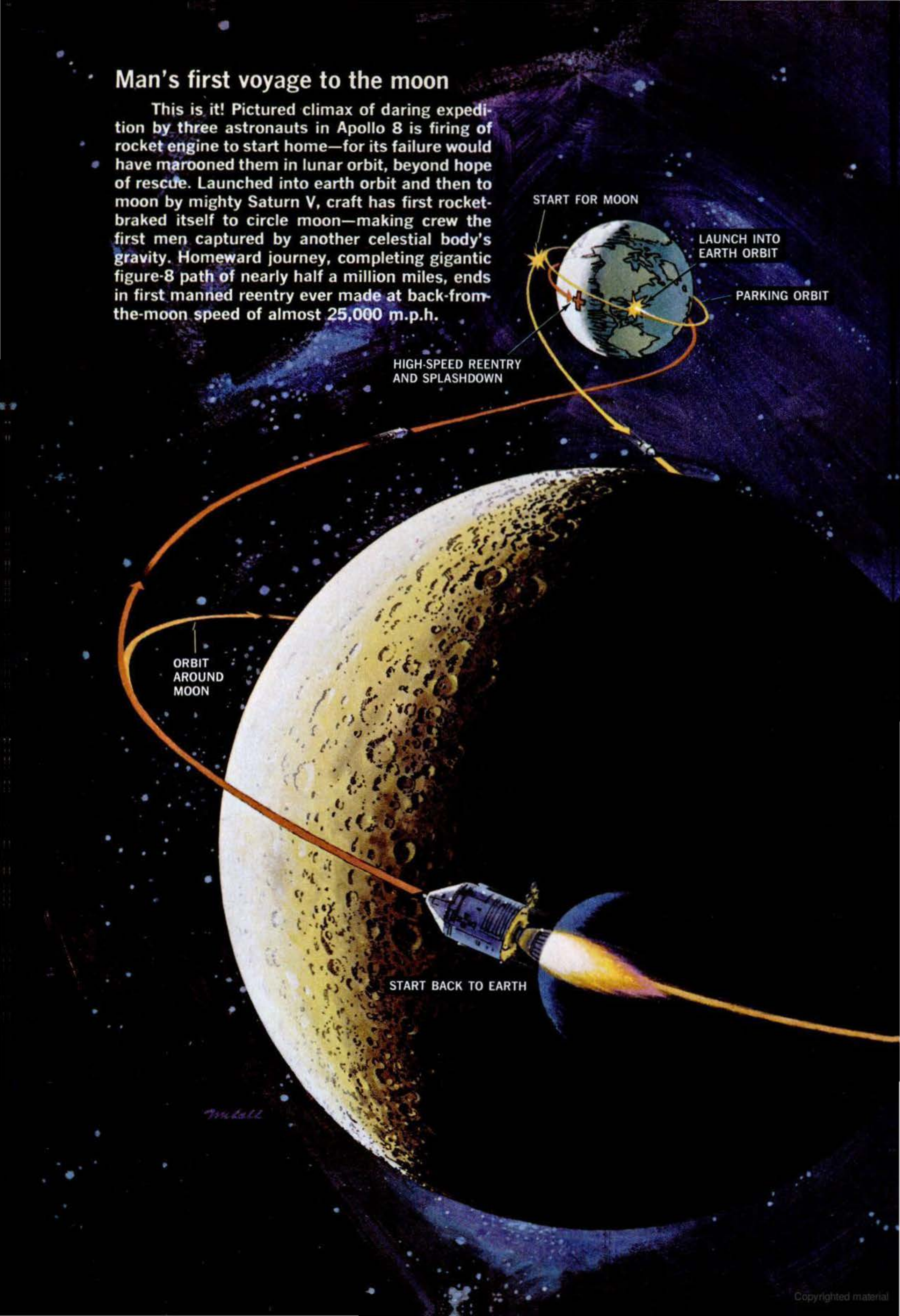


Wallabug is a lightweight two-seater intended for competition use. Steel-tube frame assures sturdy construction. Several body types are available.



Man's first voyage to the moon

This is it! Pictured climax of daring expedition by three astronauts in Apollo 8 is firing of rocket engine to start home—for its failure would have marooned them in lunar orbit, beyond hope of rescue. Launched into earth orbit and then to moon by mighty Saturn V, craft has first rocket-braked itself to circle moon—making crew the first men captured by another celestial body's gravity. Homeward journey, completing gigantic figure-8 path of nearly half a million miles, ends in first manned reentry ever made at back-from-the-moon speed of almost 25,000 m.p.h.



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What the Apollo 8 Moon Flight Really Did for Us

By DR. WERNHER VON BRAUN
Director of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

Our first manned expedition to another world, by performing a series of unprecedented space feats, has brought about the possibility of setting foot upon the moon this summer

"The moon is essentially gray. Looks like plaster of Paris . . . Langrenus is quite a huge crater . . . a central cone . . . walls are terraced . . . Bill and I are sharing the rendezvous window . . . We're just about over Messier and Pickering right now . . ."

Men had voyaged to the moon. Apollo 8 was in lunar orbit—and James A. Lovell Jr., Command Module Pilot and navigator, was telling what the crew saw. His companions were Frank Borman, Commander, and William A. Anders (a "Lunar Module Pilot" without a moon-landing Lunar Module), acting as photographer. The courageous astronauts' safe return, last Dec. 27, capped a fantastic space feat.

What did Apollo 8 accomplish, besides thrill-

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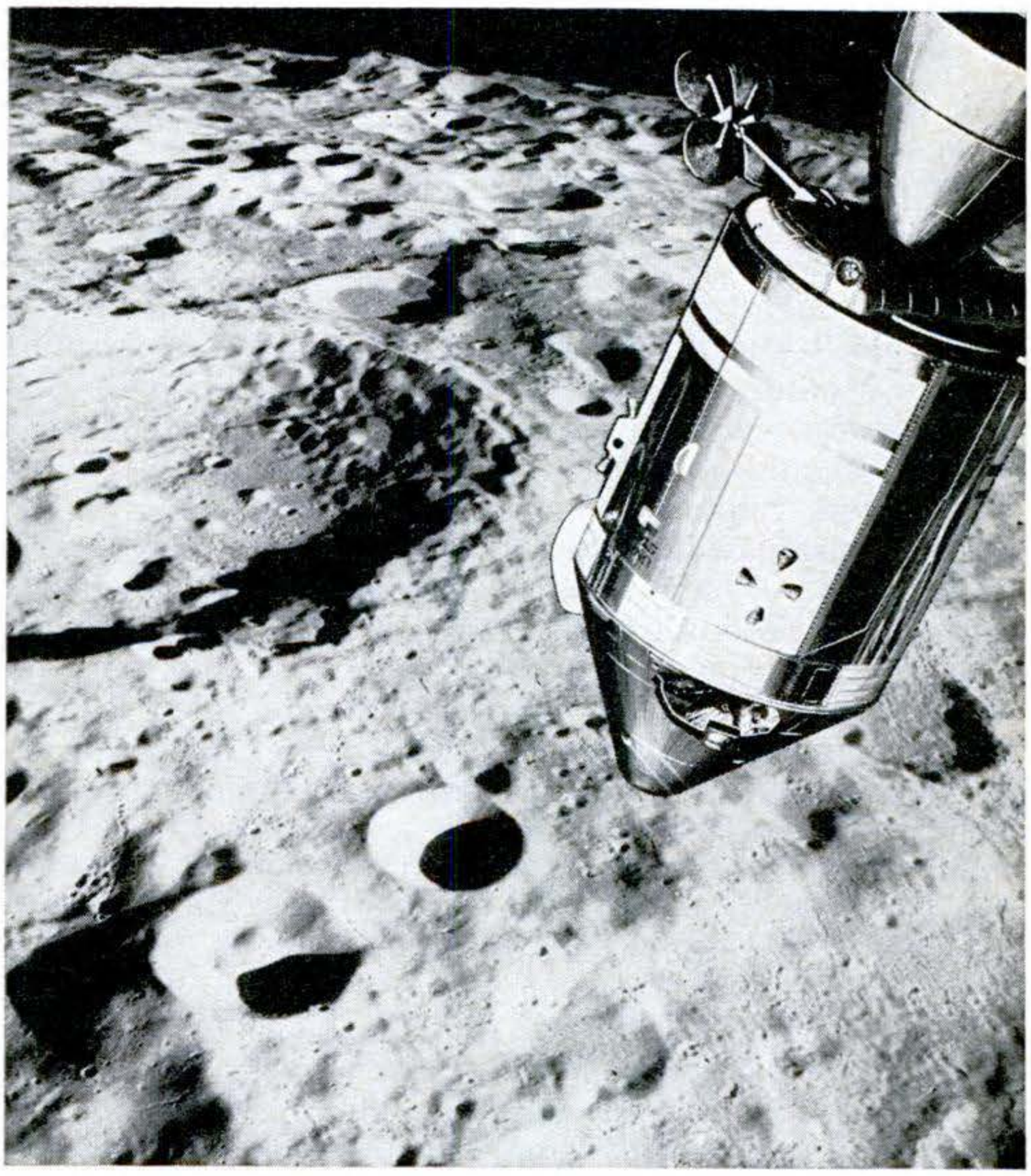

HOW ASTRONAUTS VIEWED THE MOON FROM 70-MILE HEIGHT

Drawing of Apollo 8 spacecraft, cut away to show an astronaut at a window, is superimposed (in nose-down observing attitude in which it orbited moon) on superb Apollo 8 photo of scenery on moon's far side.

PAINTING BY BOB McCALL

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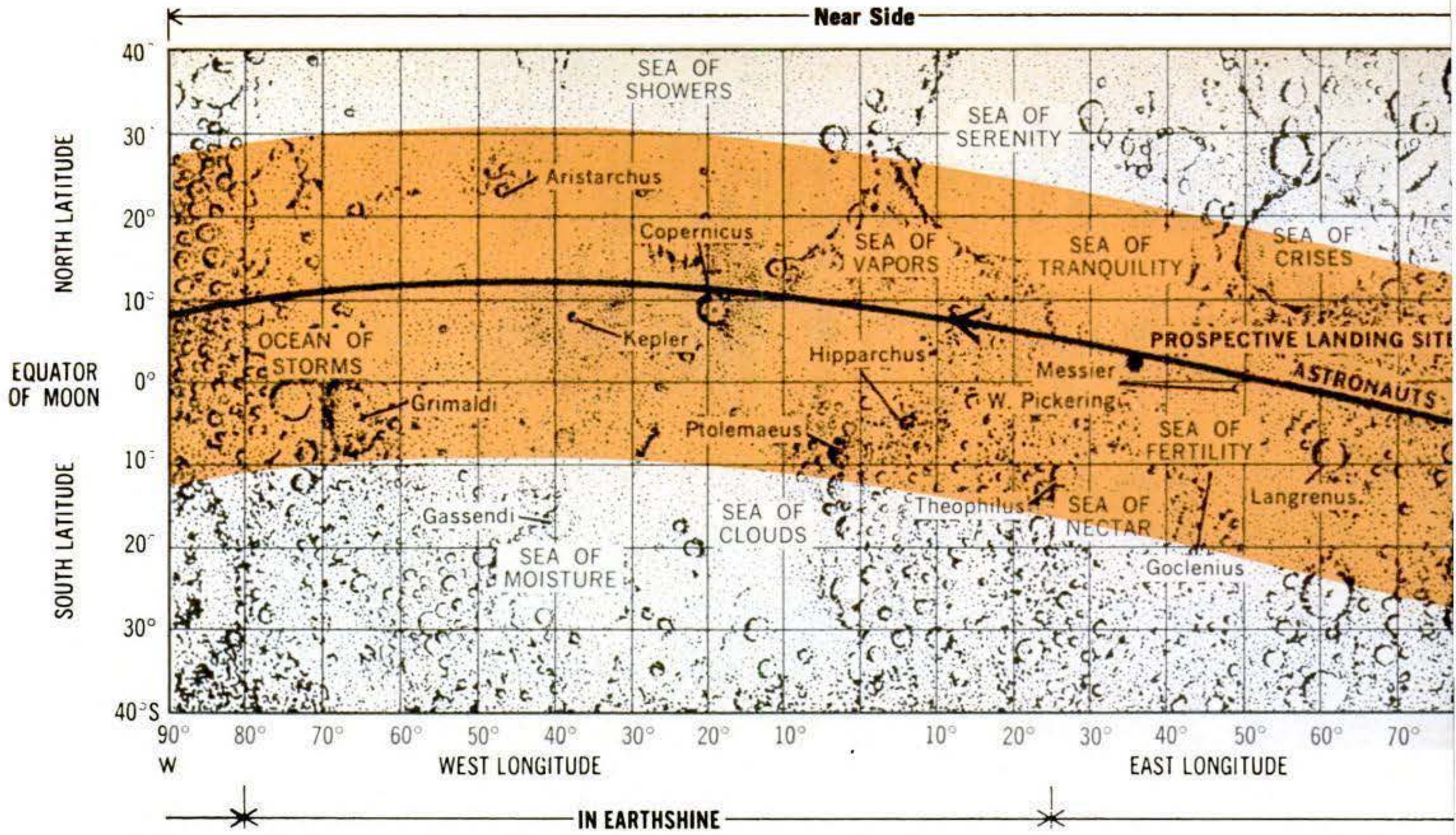

Where Apollo 8 crew explored the moon

Colored band on PS-exclusive map marks region of moon, about 750 miles wide and 6,790 miles long, within extreme range of sight from spacecraft circling at 70-mile altitude. Wavy black line at its center is path of craft, in orbit inclined 12 degrees to lunar equator. Crew saw part of visible belt in

ing the world with the highest of high adventure? It took key steps toward a manned lunar landing—and their complete success was reflected in immediate announcement by NASA of what comes next and when:

Apollo 9—the first manned test of the Lunar Module, in a 10-day earth-orbiting mission tentatively set for a Feb. 28 launch—should be under way by the time this is read. Subject to its success, Apollo 10, this spring, will make a second voyage to the moon—where, this time, astronauts in the Lunar Module are to skim within 10 miles of the surface.

If all has gone well thus far, the actual landing can be attempted by Apollo 11 this summer. Gemini veterans Neil A. Armstrong, Edwin E. Aldrin Jr., and Michael Collins are to be the crew.

In preparing the way to the landing, all preceding missions will have played essential roles—and that of Apollo 8 was made clear by NASA beforehand:

What Apollo 8 set out to do. These were announced to be the mission's aims:

- To boost the first crew with the mighty Saturn V moon rocket.
- To pioneer starting a manned spacecraft on a trajectory to the moon.
- To test the Apollo radio system and its navigation system at lunar distance.
- To put a manned spacecraft into lunar orbit—thus practicing a maneuver indispensable to the moon-landing plan.
- To observe and photograph lunar landmarks usable for guidance.
- Also, among numerous other things, to gain practical experience in making midcourse corrections, controlling the spacecraft's interior temperature, using the onboard computer, and supporting a lunar mission from earth.

How well Apollo 8 accomplished every aim may best be seen from its story:

A perfect launch. Precisely on schedule at 7:51 a.m., Dec. 21, the towering white Saturn V shook the earth with its blast as its 363-foot-high bulk rose from Complex 39A at Cape Kennedy. Apollo 8—takeoff weight, 6,218,558 pounds—was on the way to the moon.

Into an earth-circling "parking orbit" at almost exactly the intended height of 119 statute miles, the Saturn V put a 142-ton space vehicle consisting of Saturn V's top stage (S-IVB), its Instrument Unit, and the manned spacecraft in the nose, made up of the conical 11-foot Command Module and the cylindrical 22-foot-long Service Module.

Go or no-go? Now came the first of a

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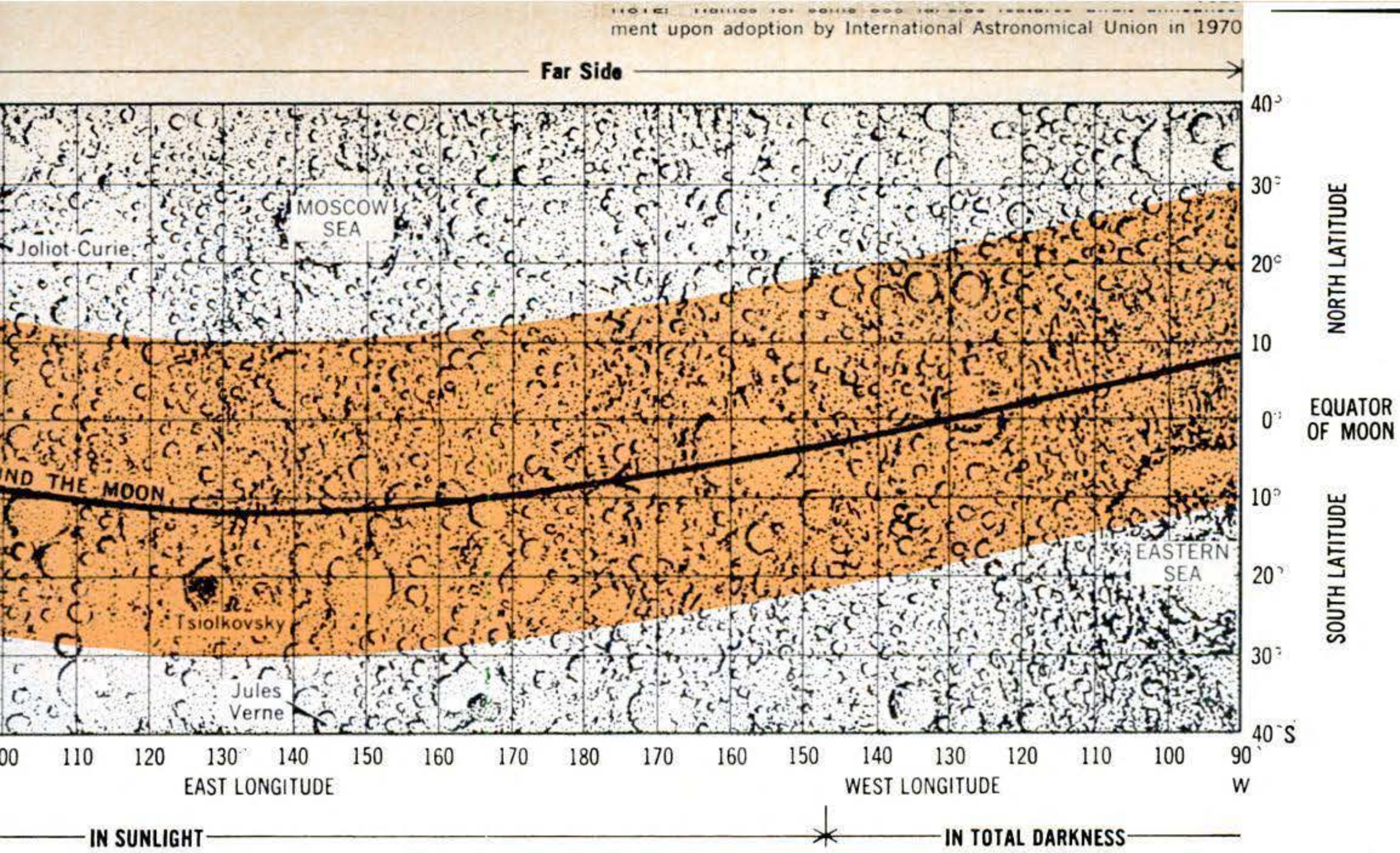

full sunlight of lunar day. Much of rest, though in lunar night, could be glimpsed by earthshine (reflected light from earth). From their preflight homework, astronauts recognized prominent craters at sight. They viewed a prospective landing site early in lunar day when long shadows showed up relief best. Mercator-style map, going clear around moon, shows central zone of both near and far sides.

series of decision points—whether to commit Apollo 8 to head for the moon. For the astronauts' safety, this and subsequent major steps would be taken only if tracking and telemetry showed all was well with crew, spacecraft, and the Saturn V's third stage. To the crew, everything looked fine. As Apollo 8 circled the earth once and part way around again in its parking orbit, NASA's Mission Control Center at Houston carefully evaluated its own telemetry records. Finally, the crucial decision was made:

"Apollo 8, you are go for TLI." That was short for "translunar injection," the start toward the moon.

What looked like a blazing white comet streaked across the night sky over Hawaii, trailing silvery spray. The crew had reignited Saturn V's 230,000-pound-thrust third-stage engine—and its burn of more than five minutes raised their speed from some 17,400 to 24,200 m.p.h., enough to enter a moonbound trajectory.

Traveling faster than anyone had before (and they would return at even higher speed), the crew quickly passed the 851-mile mark for the greatest distance man had ever ventured from earth, set by Gemini 11 in 1966. They would go hundreds of times as far to reach the moon, 220,000 miles from the earth at the time.

With Saturn V's duty flawlessly done, the spacecraft separated from its top stage and its sophisticated guidance unit, 20 minutes after translunar injection. The

[Continued on page 220]

Apollo 8 photograph with long-focus lens, looking south, reveals minute details of 40-mile-wide crater Goclenius (in foreground) and of others beyond it.

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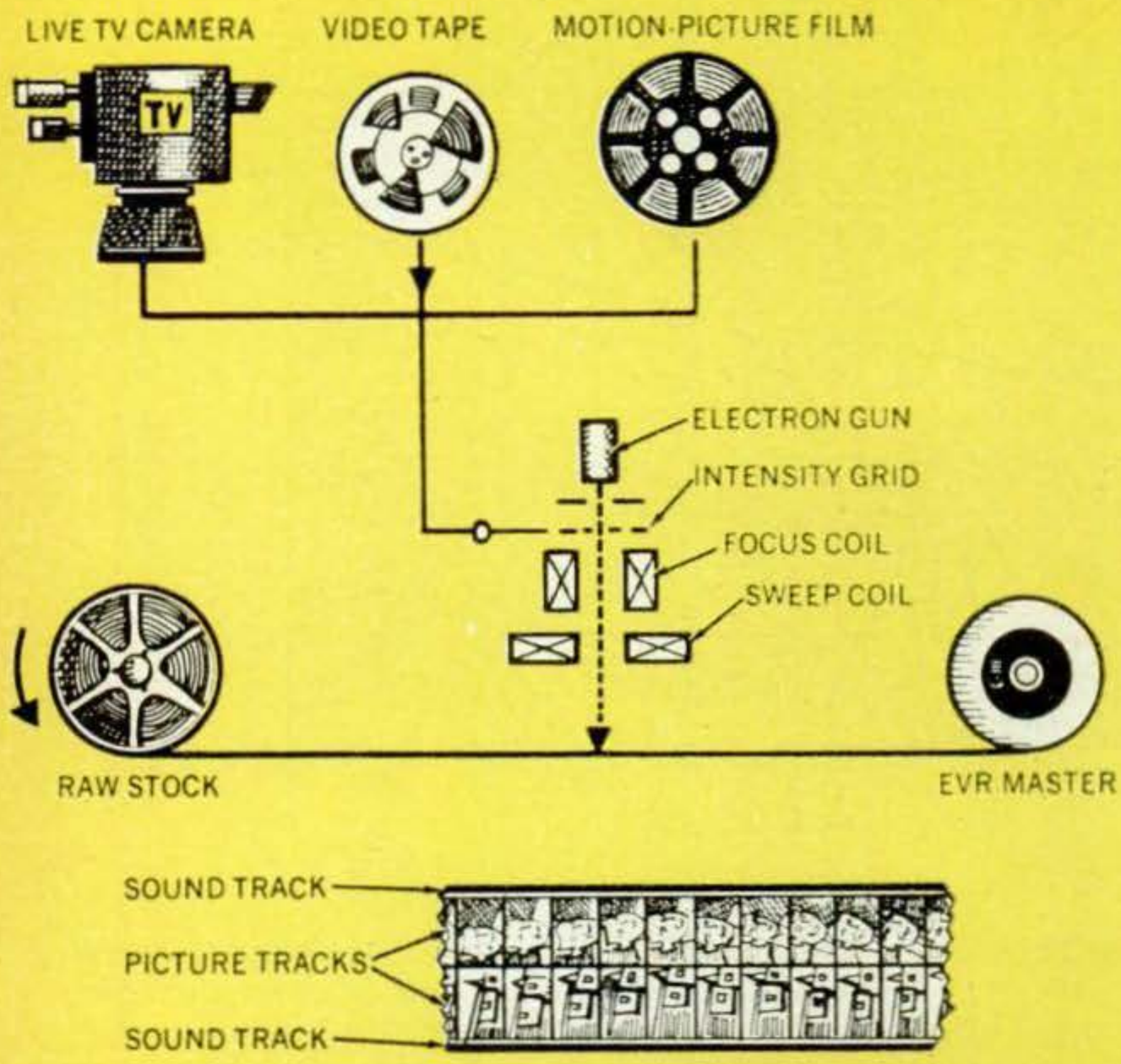
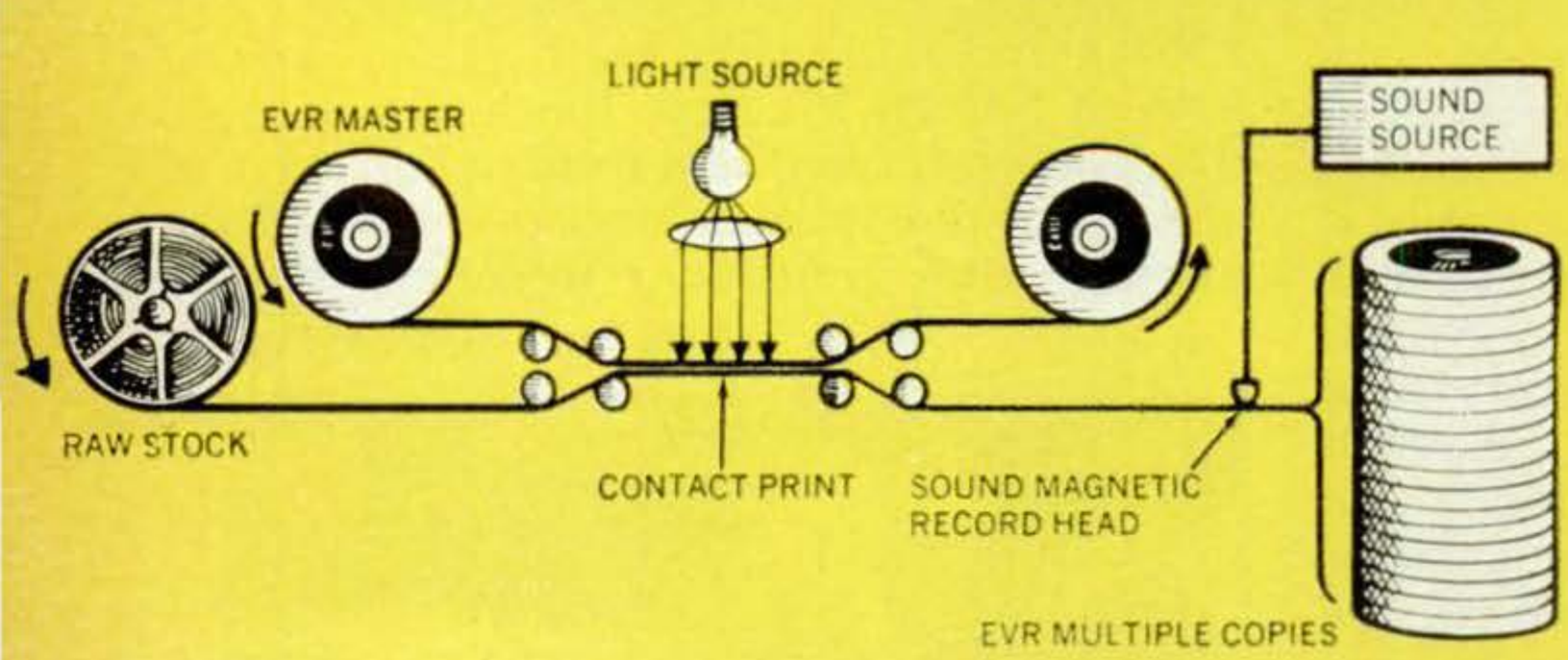
ELECTRONIC VIDEO RECORDING: HOW IT WORKS



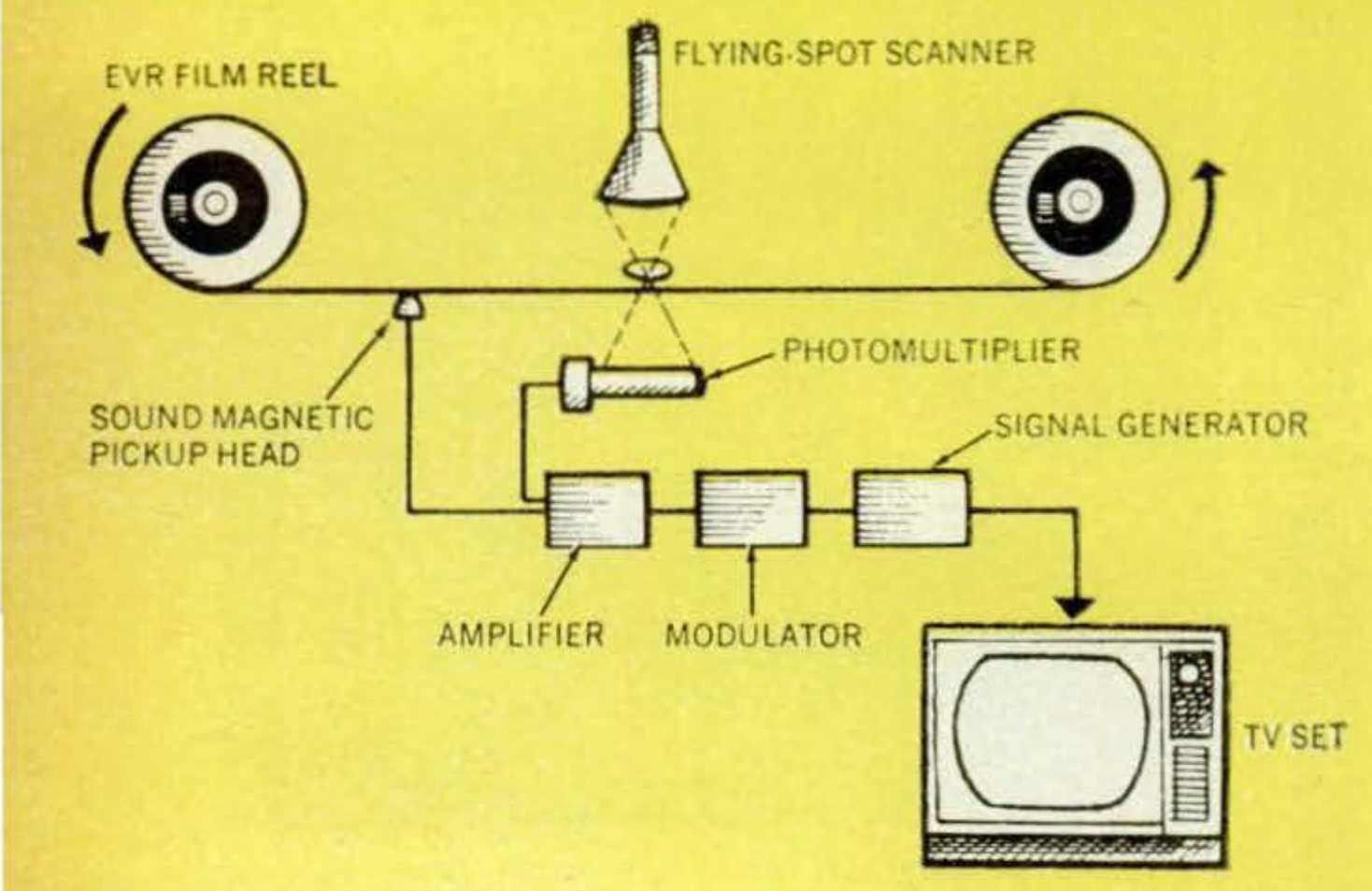
The electron-beam master recorder

Master film images are generated from an electron beam whose intensity varies with signals coming from the picture source. As explained by Dr. Peter C. Goldmark, president of CBS Laboratories, who headed EVR's development, "Because electron beams can be brought to a much sharper focus than light, the picture frame can be extremely small and still maintain excellent image resolution." Each frame is swept with 525 beam lines —the standard TV horizontal sweep rate, providing compatibility for playback through standard TV sets. The format is two picture tracks with a magnetic sound track for each on the film's outer edges. Film width is .344 inches.



The high-speed duplicator

A 20-minute program can be printed in 30 seconds by multiple printer. Extra-wide eight-track raw film stock is slit to two-track EVR format. Magnetically recorded sound-on-film, synchronized with picture, is then added. Just as success of phonograph records depended on ability to cheaply produce copies, EVR's success will depend on low-cost film duplication.



The EVR player

Photographic information on film is translated into electrical signals with flying-spot scanner and photomultiplier. Signal, amplified and modulating radio-frequency carrier, is fed to TV set through antenna terminals. Sweep rate of 525 lines per frame, together with appropriate light-beam synchronizing pulses coming from sync windows in film, locks in TV set's internal sweep generators for display of reproduced picture. Sound is reproduced by magnetic heads reading recorded tracks on film running at a rate of six inches per second.

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EVR —Canned Movies from Your TV Set

Electronic Video Recording is the latest technological breakthrough for education and home entertainment

By SAM SHATAVSKY / *Electronics Editor*

A complete audio-visual entertainment and educational center in your home—that's what is coming with the introduction of CBS's new electronic video-recording system (EVR). Just as a long-playing record stores sound conveniently and inexpensively for later replay on a record player, EVR stores pictures and sound on a reel of film for playback through a standard television set.

Nothing like videotape recording. EVR uses electron-beam image recording on film to generate extremely small picture frames identical with those on movie film. The film is for playback only; you will not be able to make your own recordings, but will buy ready-made program reels produced by CBS and its licensees. Any motion picture, video-

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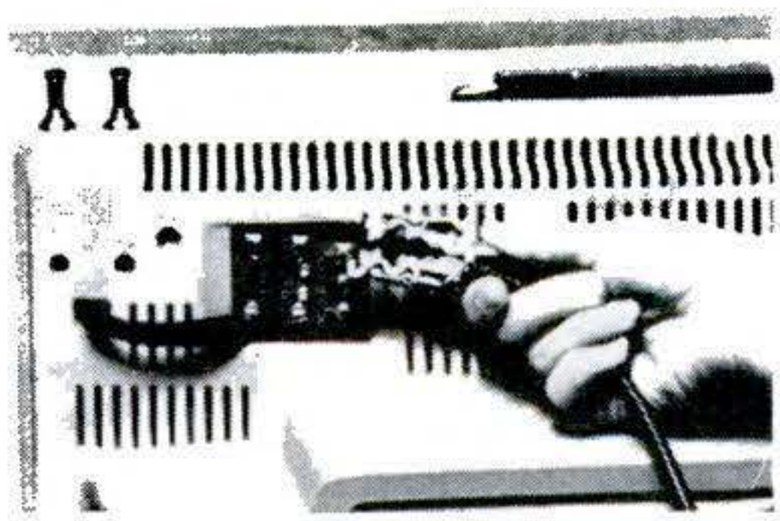

EVR player is compact and simple to operate. Twin leads from player are clipped onto TV set's antenna terminals. After film cartridge (about size of a magnetic-tape reel) is placed on spindle, player starts with push of a button. Playing time is 52 minutes for each seven-inch reel. There are controls for fast-forward, rewind, slow-scan, and stop-motion display of any picture frame.

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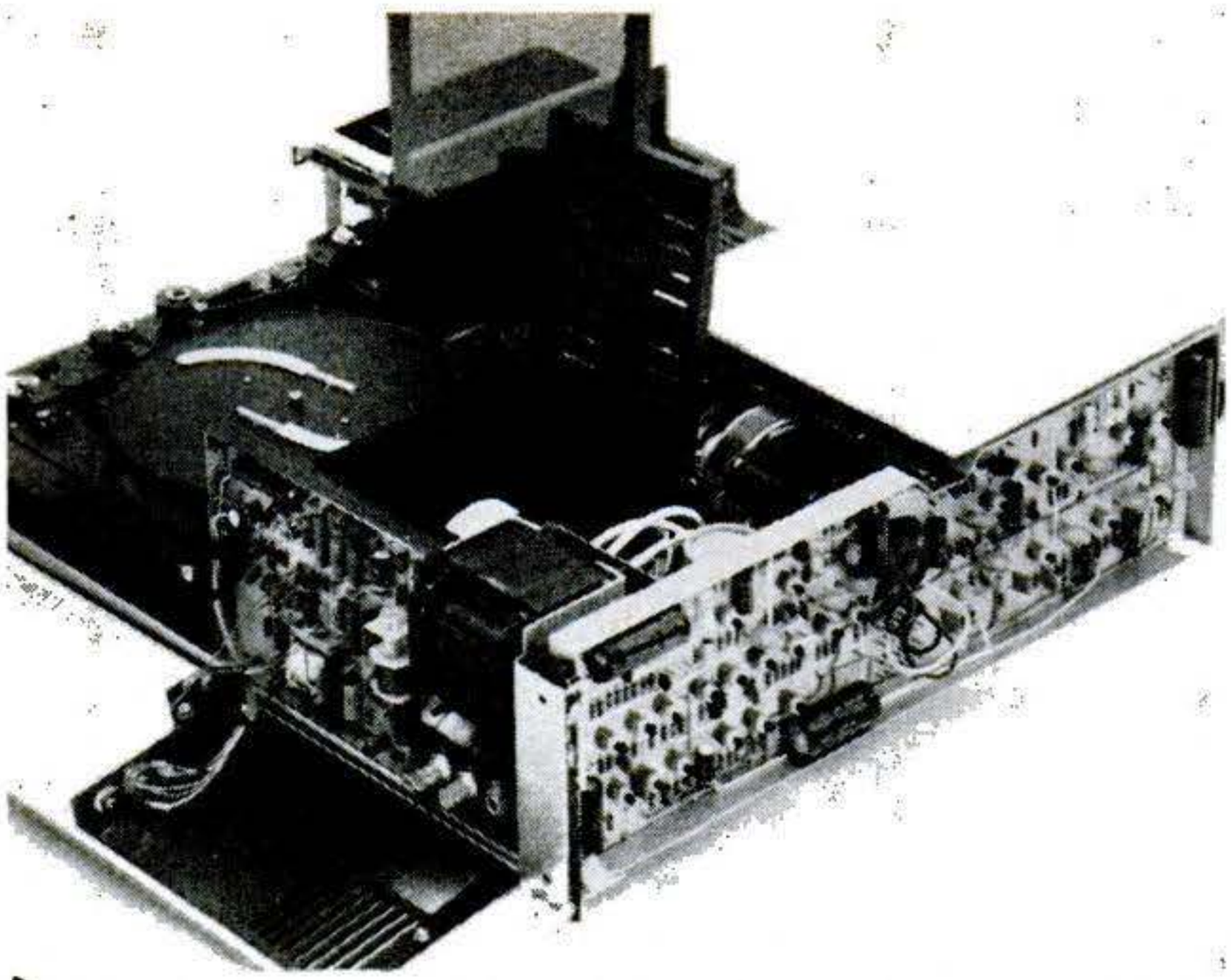
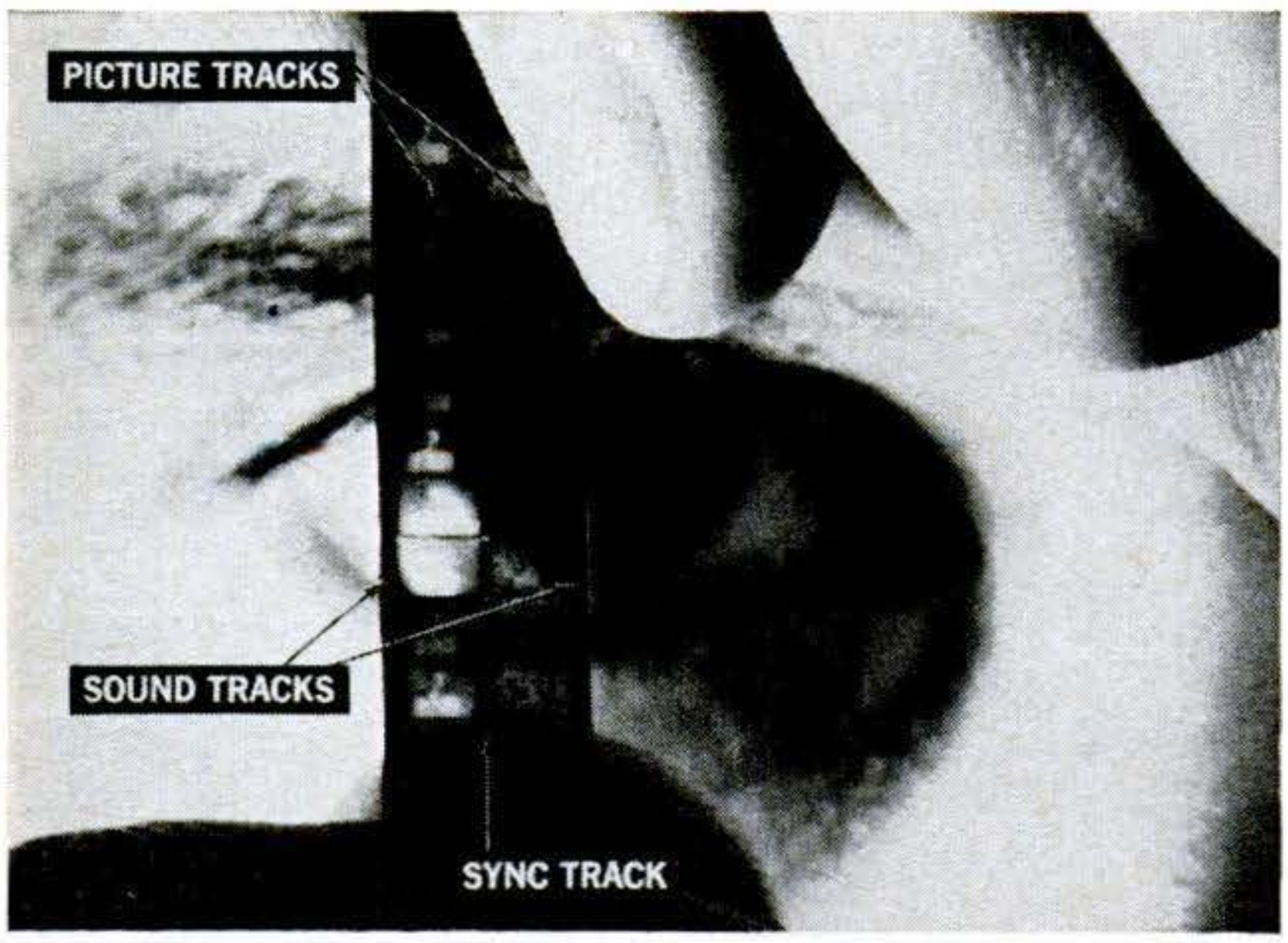
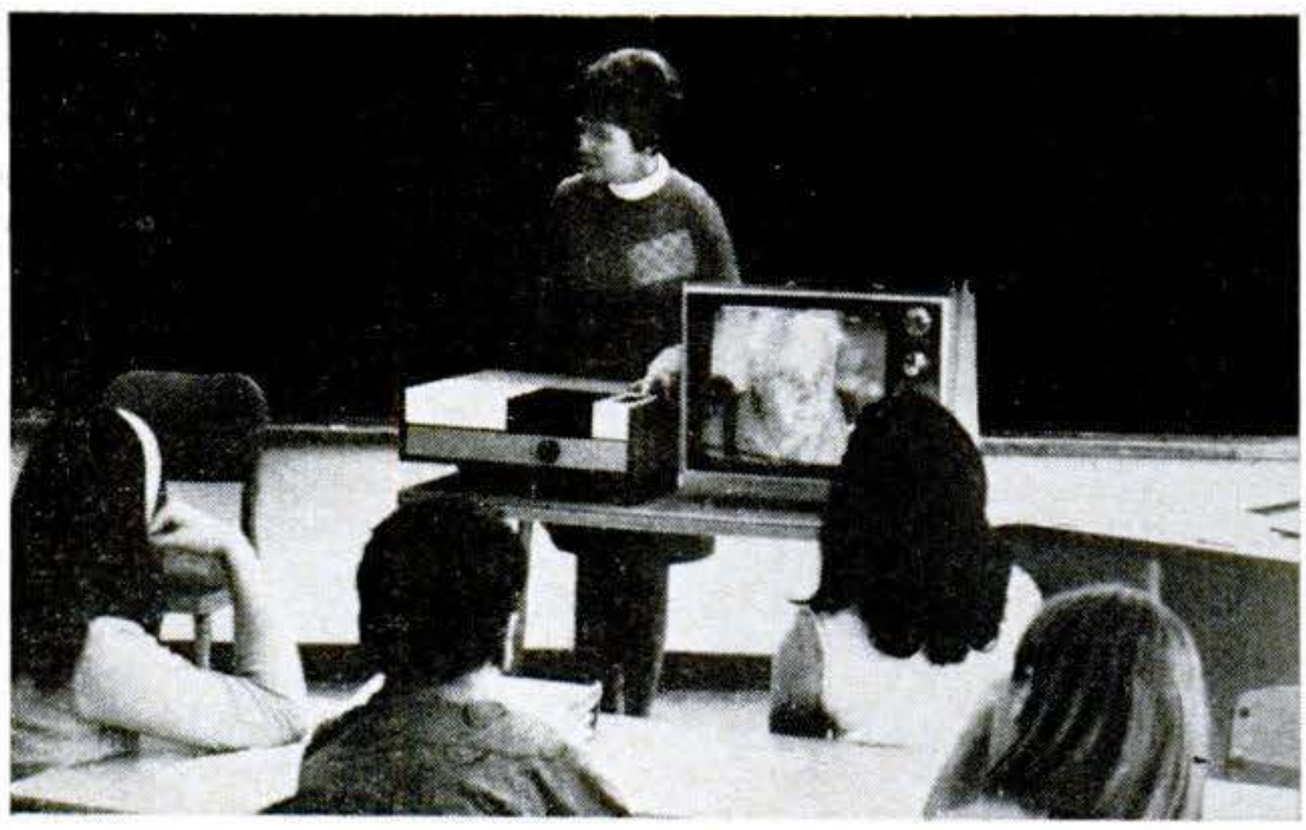


Player chassis houses electro-optical transducer system: the flying-spot scanner, photomultiplier, and electronic circuits, together with automatic-threading film-transport mechanism.



Thin film is dual-tracked and carries magnetic sound tracks on outer edges. Synchronized-light windows allow speed control without sprocket holes. Picture frame is ⅛ by 1/10 inch.



In classrooms, EVR is expected to play leading role, providing selected programing at teachers' discretion and convenience. Students will also operate easy-to-use players in learning labs.

tape, or live television program can be commercially recorded for EVR playback.

The whole family benefits. An EVR cartridge is about the size of an ordinary seven-inch magnetic-tape reel. By simply inserting one into the playback machine, Dad can sit at his TV set for an evening of golf lessons. Junior can bone up for a science exam with cartridges from the public library. Mother can take homemaking, bridge, or language courses. For entertainment, you'll have a choice of the latest movies, plays, and concerts. This will all come through your TV screen via the EVR player.

Because this new video recording system has a horizontal resolving power of up to 600 TV lines per picture frame, without interlace, picture quality is excellent.

EVR is also superior to magnetic videotape because of its high-speed low-cost duplication and the low cost of the film. It is predicted that cartridges will sell at the same price level as records with about the same playing time. Low film speed (six inches per second) gives fewer transport-mechanism problems—another advantage over the high-speed videotape machines.

CBS is setting up a plant for high-speed duplication and will develop the EVR market through the television, publishing, and motion-picture industries. In license agreements with CBS, Motorola will manufacture EVR players and the New York *Times* will develop educational EVR cartridges.

Although introduced in black-and-white, EVR will ultimately go to color. The initial price of a player is estimated at $800, but without question, this new sight-and-sound recording and playback system promises to open new doors to gaining knowledge and enjoying entertainment at home. PS

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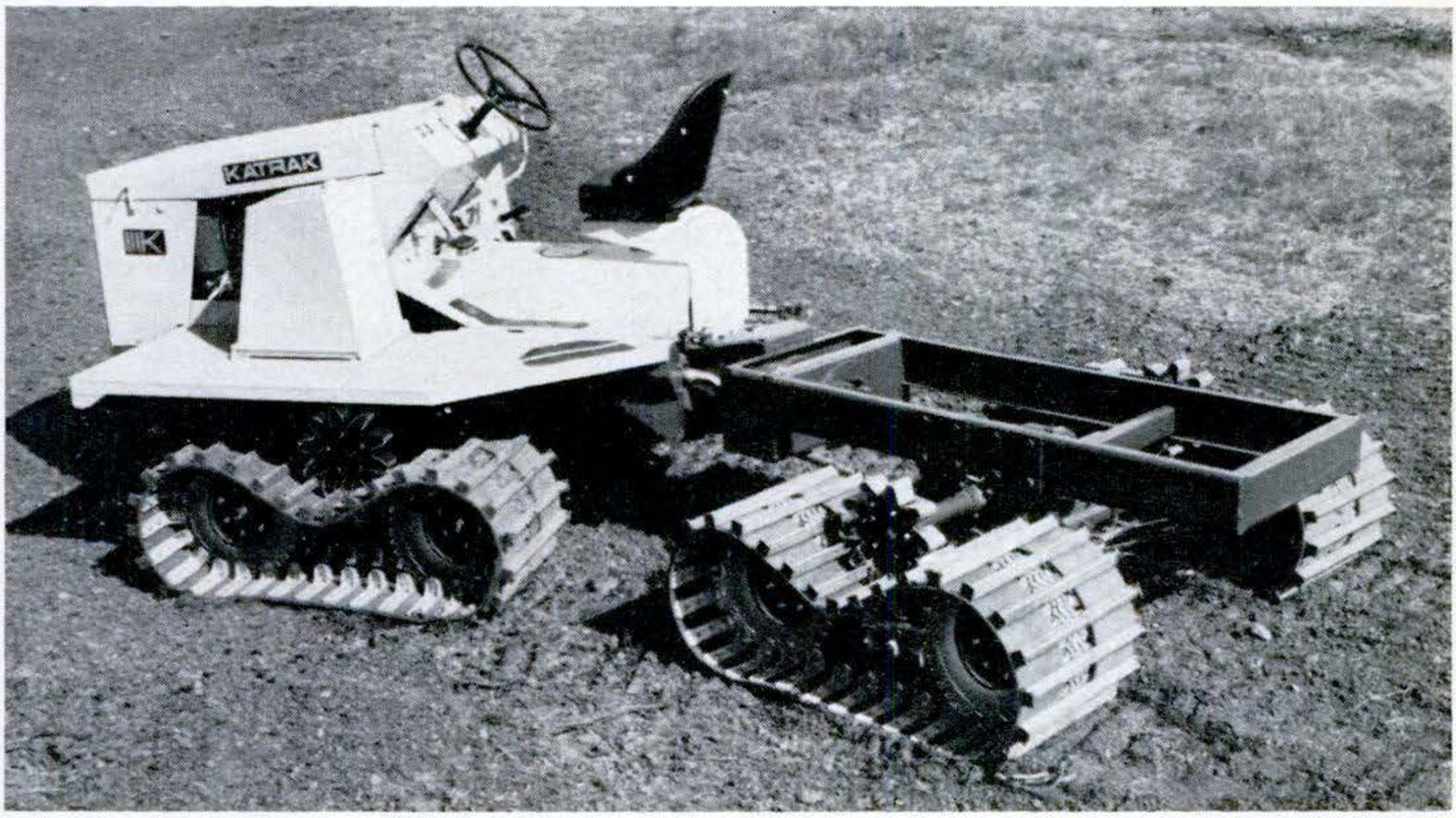
Motorbike in a handbag

A 60-pound mo-ped, made in Kiel, Germany, collapses into a unit small enough to carry in a car trunk or its own carrying case (photo above). Frame and wheels are made of aluminum; and engines, under 50cc, put out .7, 1.3, or 1.5 hp. Speed with the hottest engine is about 20 m.p.h. The midget bike has drum brakes on both wheels.



Hauler has four-track drive

The drive line of the industrial all-terrain Katrak K-60 applies torque to all four tracks. Its "walking-beam" suspension is designed to keep treads flat on uneven ground, and triangular terrain-depressing cleats are said to give improved traction. The K-60, with a 200-hp. Ford engine and eight forward speeds, can carry a 5,000-pound load. Track drive sprockets are self-cleaning. Made by Katrak Vehicle Co., Canby, Ore.

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IT STROLLS, CLIMBS, BALANCES
The Fabulous

This strange beast of burden—produced by GE, sired by the Army—goes places wheels can't

If you've been thinking of multiwheel or track-laying vehicles as the ultimate in go-anywhere transportation, you may have to change your mind.

This truck on legs promises to walk to places that are inaccessible to conventional off-the-road vehicles. It was born when a group of scientists went right back to basics, and chose as their point of departure the fact that the wheel does not appear anywhere in nature—it's a man-made device, and it may be that nature has more effective forms of mobility for really tough going.

The 3,000-pound walking truck indicates that they may be right. It can balance on two legs, and it can walk over and around large obstacles. It can walk forward and backward, and it can turn around. Top speed is five m.p.h. It can carry a 500-pound payload, and lift loads up to 500 pounds with one foot. It can drag a 1,000-pound load across a floor.

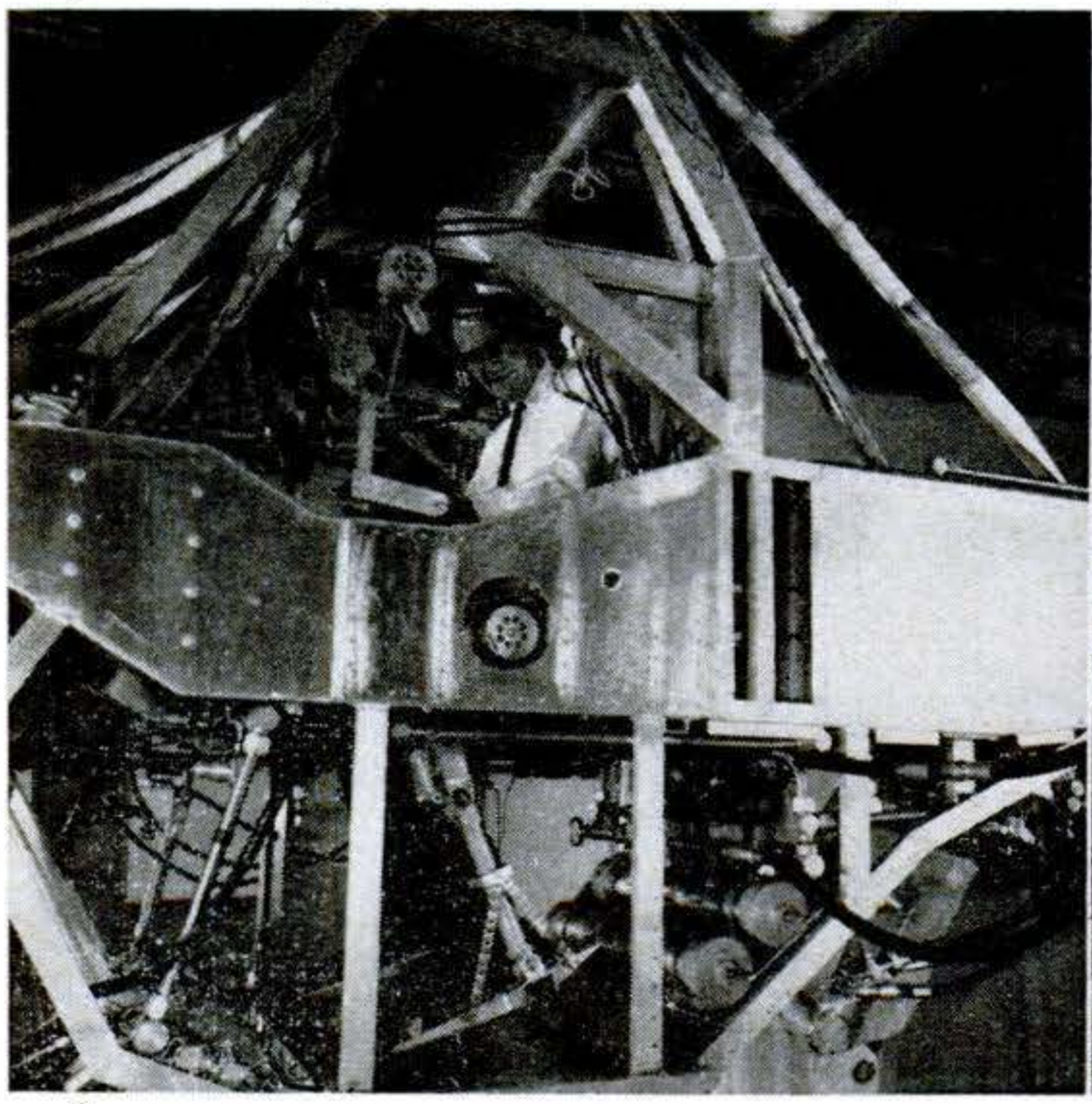
The power unit is a 90-hp. gasoline engine that drives a pump for a high-pressure hydraulic system. The legs are moved by hydraulic actuators with an oil flow of 50 gallons per minute at 2,400 pounds per square inch.

The actuator servos are hydromechanical and need no electronic elements. They work two ways, taking orders from the controls via the master actuator, and feeding back to the operator. The feedback tells the operator something about the force he is using to walk the truck, and enables him to make adjustments in handling the controls.

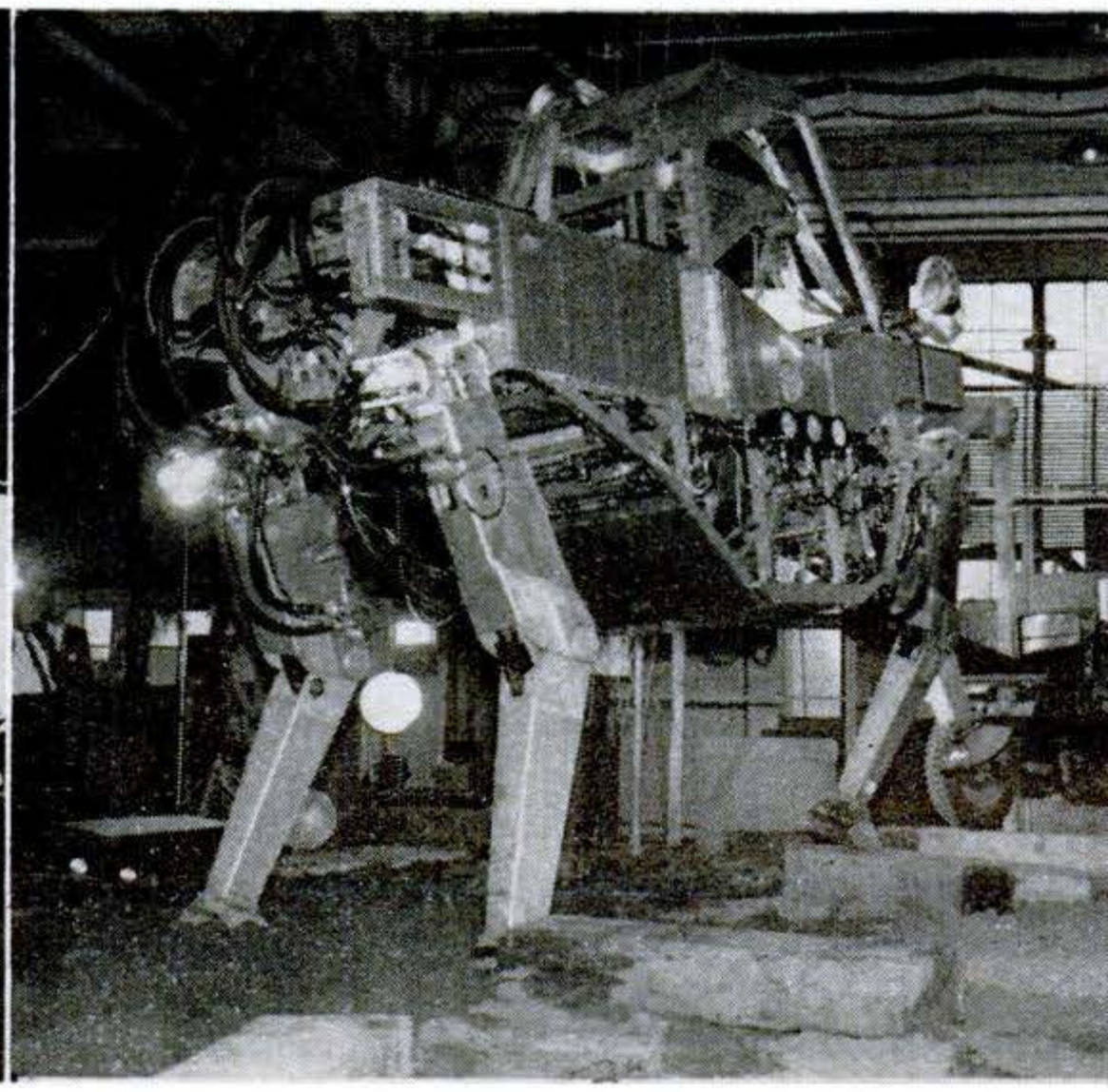
How do you "drive" it? A tractor-type seat leaves both arms and legs free to drive the truck. The seat is adjustable fore and aft, up and down, and for tilt

Continued

Operator sits in a cage-like cabin on top of the truck, with his head about 15 feet off the ground. Both his arms and both legs are in continuous use when the truck is walking; the truck legs simply mimic, in amplified form, the limb motions of the operator.



Engine and pump are held in the belly of the truck, with hydraulic pipes running to actuators in each leg for hip and knee joints. In photo at right, the truck is seen climbing a wood log stand with right-front foot and left-rear foot in the air simultaneously.



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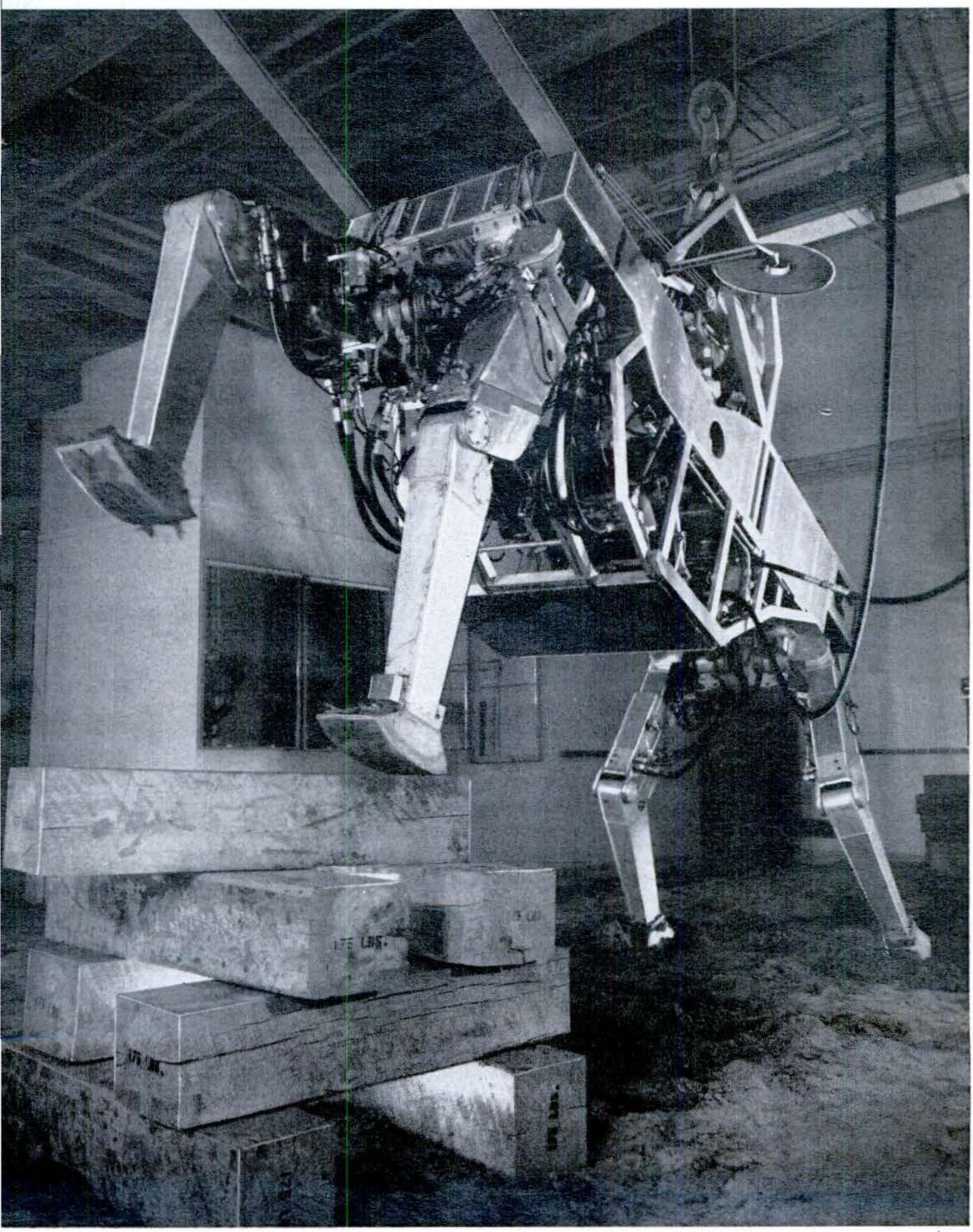
ON TWO LEGS—
Walking Truck



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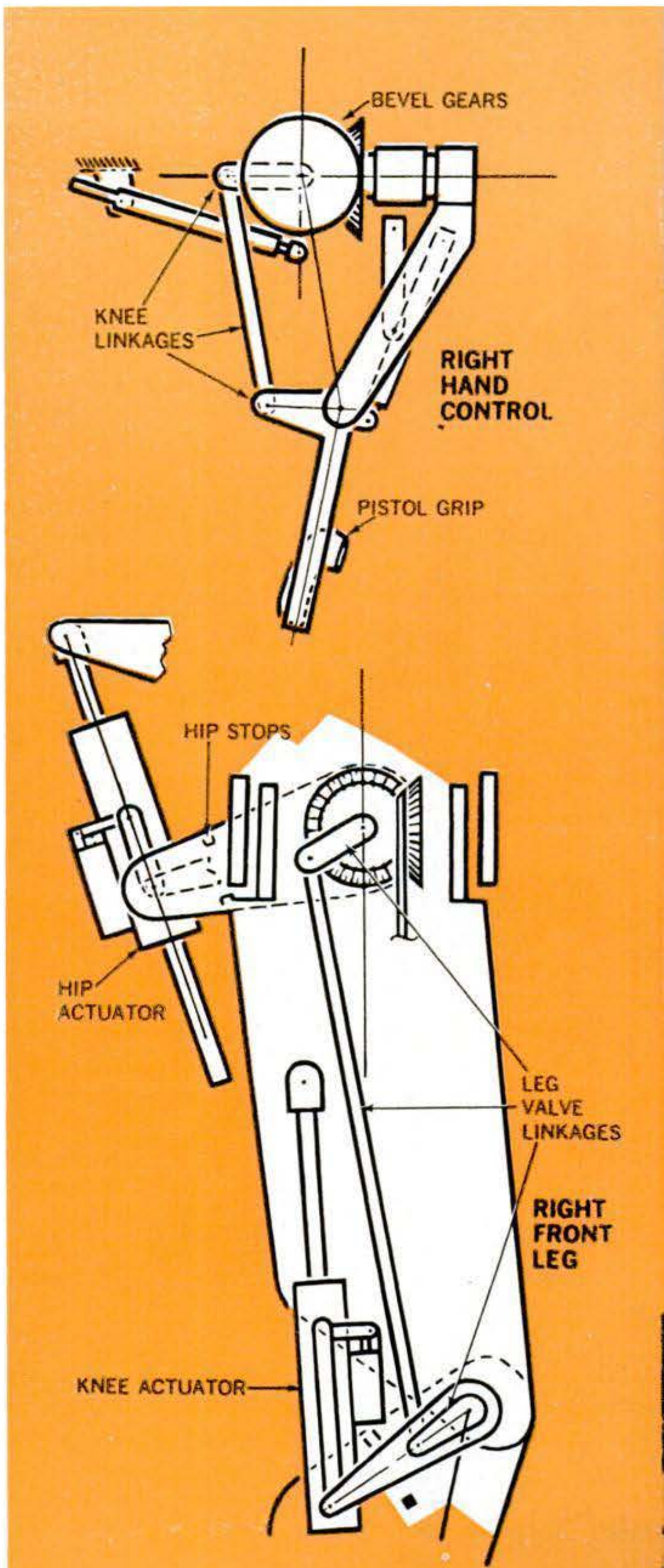
angle, like a six-way passenger-car seat.

Your arms direct the front legs of the truck, and your legs control the rear legs. Your movements are amplified four times, and your strength is limited only by the pressure in the hydraulic system. Each leg has a hip joint, thigh, knee joint, and a lower section that includes the foot. There are no ankle joints.



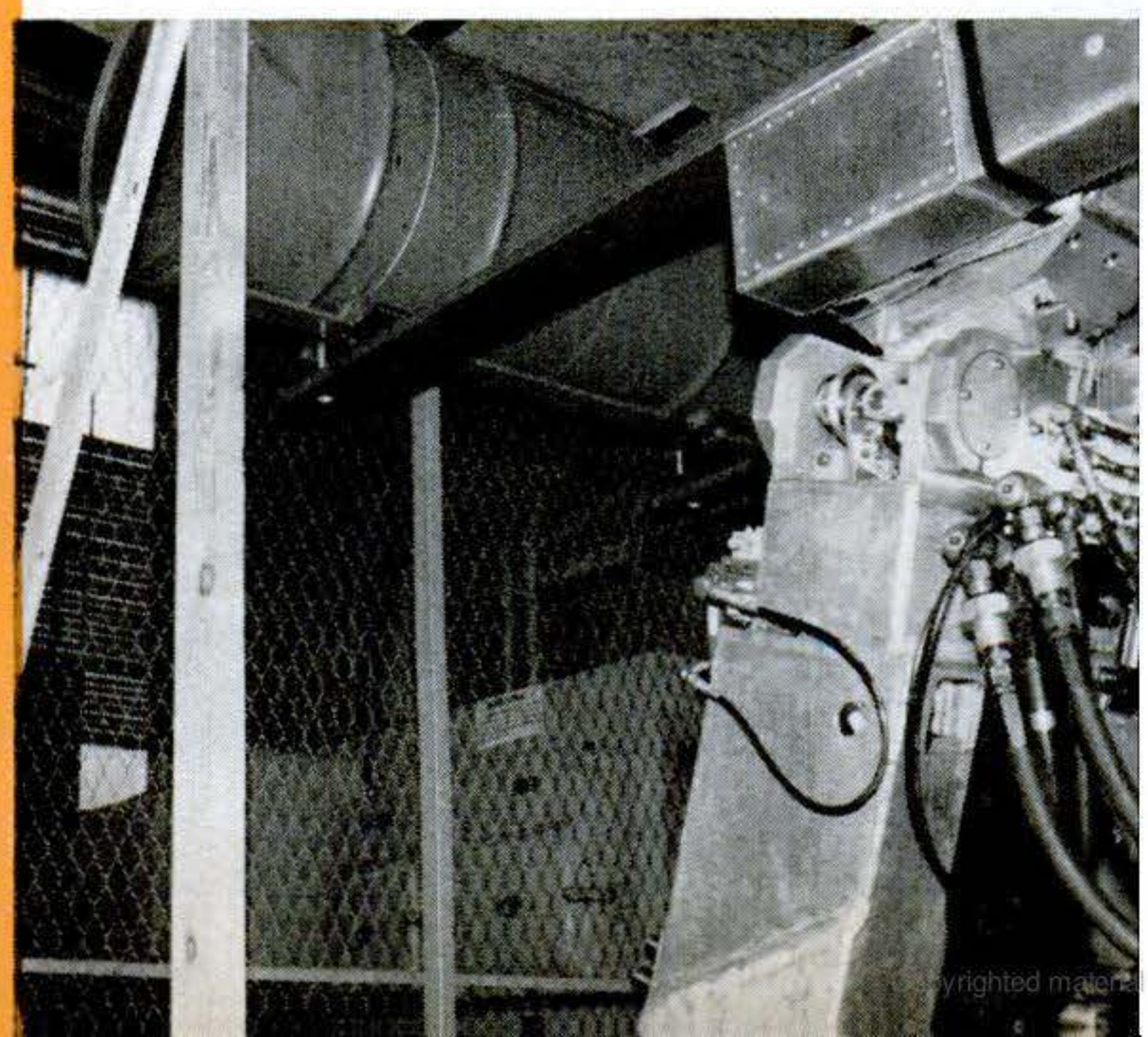
The hydraulic actuators induce motions in the truck legs that correspond to the motions of the control elements—i.e., your handgrips and pedals. The controls pick up both position and force, and the actuators respond accordingly. The machine becomes almost a rational extension of the driver, and responds to his natural, complex, neuromuscular reflexes in a simplified manner.

The hip joints have two motions (fore and aft, and sideways), while the knee joint allows only fore-and-aft motions. The hip joint allows the thigh to swing 70 degrees forward and 20 degrees backward. Mechanical stops prevent further movement. The foot can exert a force of 1,500 pounds in any direction, and even much higher forces in some cases, depending on the leg-linkage position.

The hand controls end in a pistol grip. You twist, pull, push, lift, or lower the handles, and the front legs on the truck mimic your motions.

The pedals are really shoe pads strapped to the driver's boots before he enters the vehicle.

Keeping your balance. Since your head is some 15 feet off the ground, you may be a little overcautious about lifting more than one leg at a time. But the truck will balance on two legs, and the learning process is really not a matter of skill but of developing a mental attitude. You already know how to walk, and since all



Hip joints can turn both sideways and in a fore-and-aft plane; knee joints, however, move only fore-and-aft. A mechanical linkage coordinates hip- and knee-joint motions in each leg, and mechanical stops limit angularity. At right, the walking truck is shown picking up a simulated bomb for loading into an airplane. This exercise shows the machine's ability to move with precision in performing practical tasks where working space is limited.

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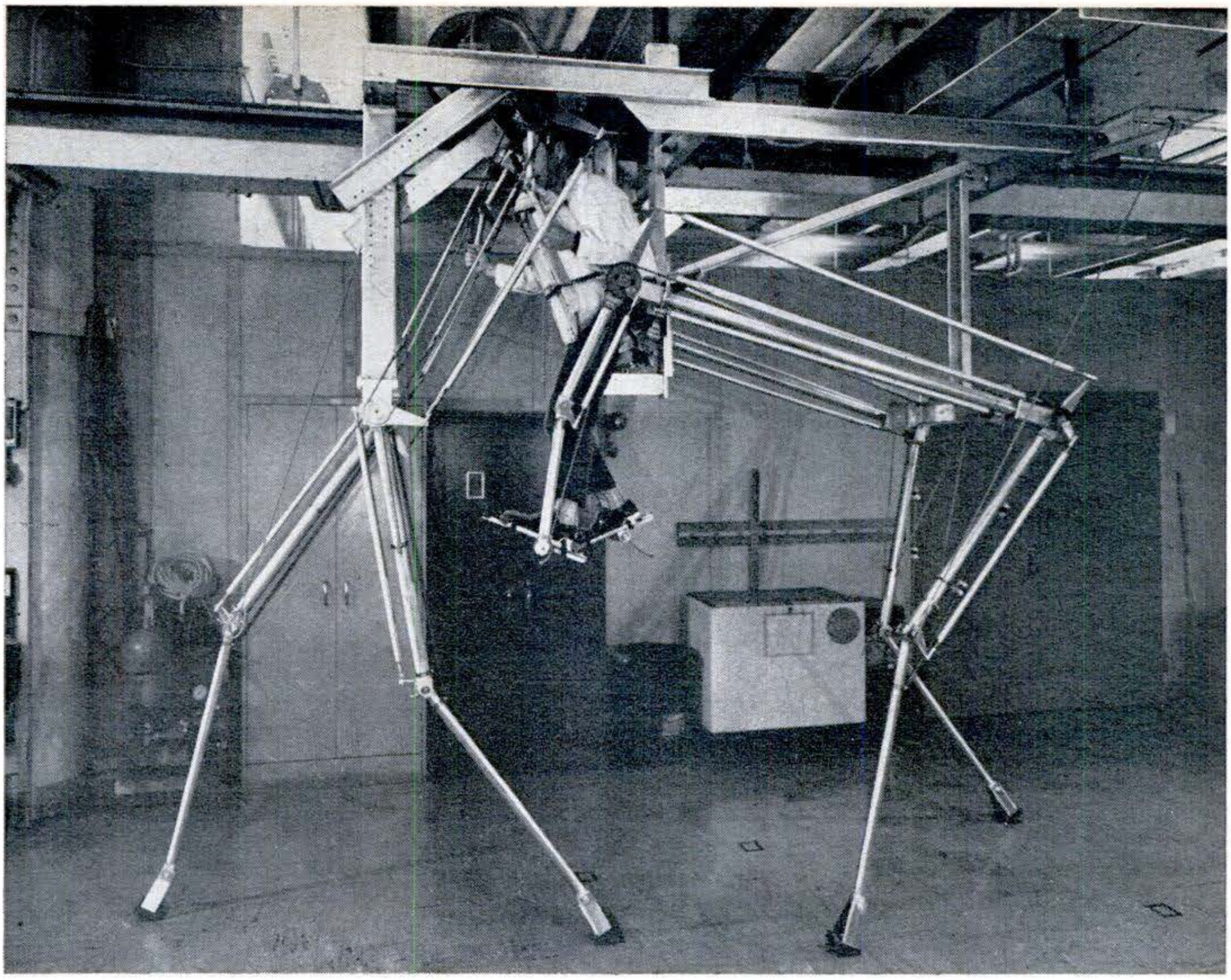

A full-scale nonpowered quadruped was built and tested as a feasibility study for the truck's control system. It is supported and moved back and forth by an overhead crane, but kinematics are realistic.

the machine does is put your natural body movements into the truck legs, you know how to handle the walking part. The truck takes its cues from your motions.

The only real difficulty the test drivers at General Electric have found (GE developed the walking truck under contracts with the U.S. Army Tank Automotive Command and the Advanced Research Projects Agency) is sensing and responding to tail-end and rear-leg motions. These parts are out of the operator's sight, and he has a hard time interpreting pitch and yaw action. The test drivers used mirrors as a training device, and after a while found they were able to do without them.

Of course, the truck doesn't walk as well as a man. It's stiff-legged and has a rough gait. But since the truck's leg motion is directed by human leg motion, the truck has a smoother gait than would normally be the case with strictly mechanical legs.

A walking truck in your future? If it could go faster and give a smoother ride, it would be a tremendous recreational vehicle. Of course the engineers are working on developing the walking truck to the point where it can move with the agility and litheness of an animal, but that day is a long way off.

But the walking truck shown here already has the ability to outperform wheeled or track-laying vehicles in several respects. It can climb extreme slopes negotiate steep river banks, ford fast-flowing streams—in fact, it would not be much bothered by an obstacle course that would stop a heavy bulldozer dead in its tracks.

As it stands today, military production will not begin until an extensive test program has been undertaken, and the lessons from it have brought about partial redesign and detail improvements wherever possible. Until then, the walking truck is strictly experimental. PE

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PS photo editor takes you WINDOW-SHOPPING IN RUSSIA

By
EVERETT H. ORTNER

What's to buy in the Soviet Union? Here's a look at some of the things your rubles will get you

Recently, equipped with four cameras and a wife to help carry them, I went to the Soviet Union, visiting six major cities plus some odds and ends of towns, and peering through the glass of countless store windows and showcases to see what is available, and at what prices, to Ivan in the way of consumer goods.

Three weeks in Russia doesn't qualify you as an expert, but if you use your eyes and legs sufficiently, you come back with lots of impressions to mull over, and, if you're a picture taker, as I am, lots of photographs to study.

Before you can have any notion of the significance of a price,

Continued

Moscow's huge department store, GUM, has three skylighted shopping galleries like this.

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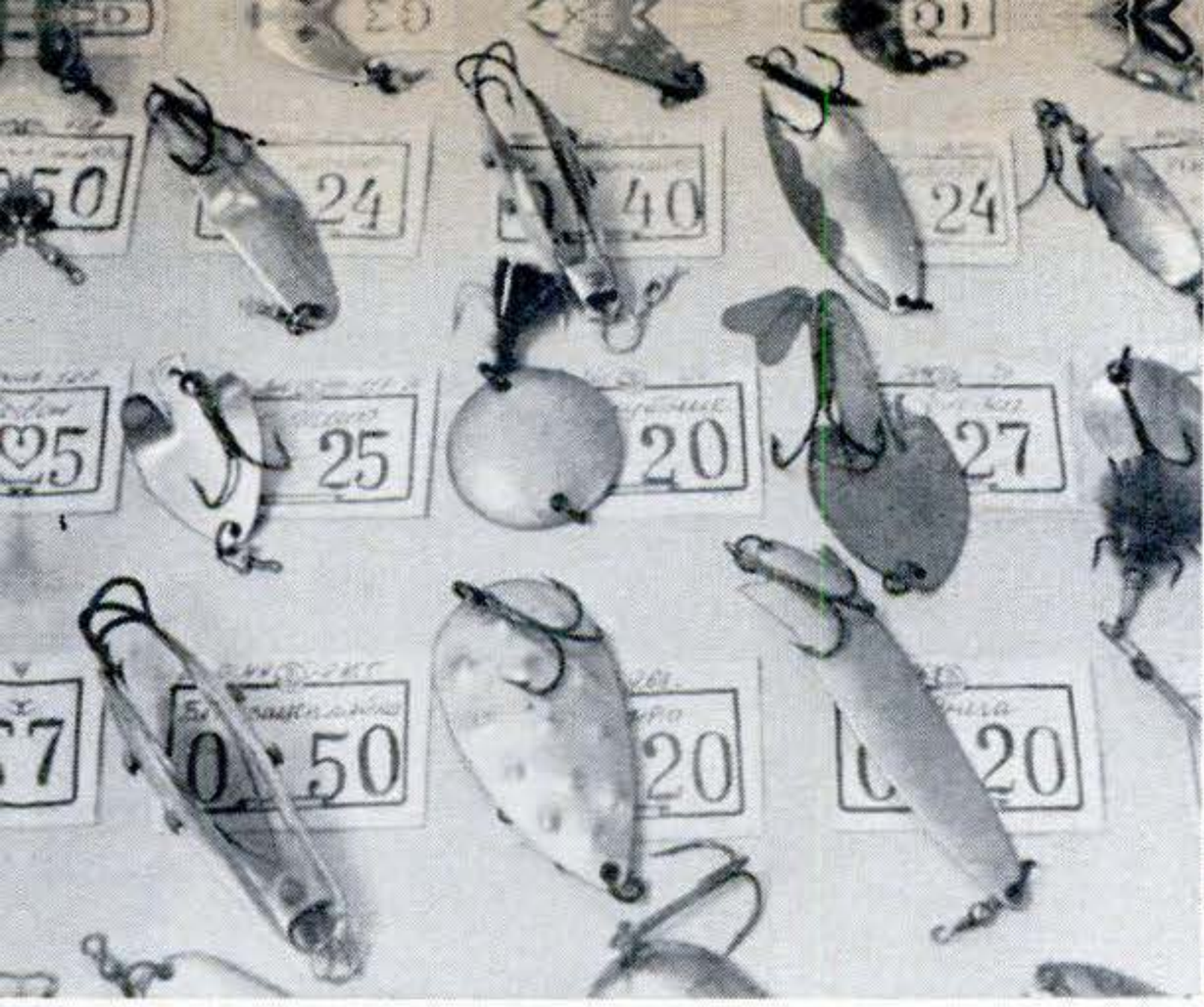


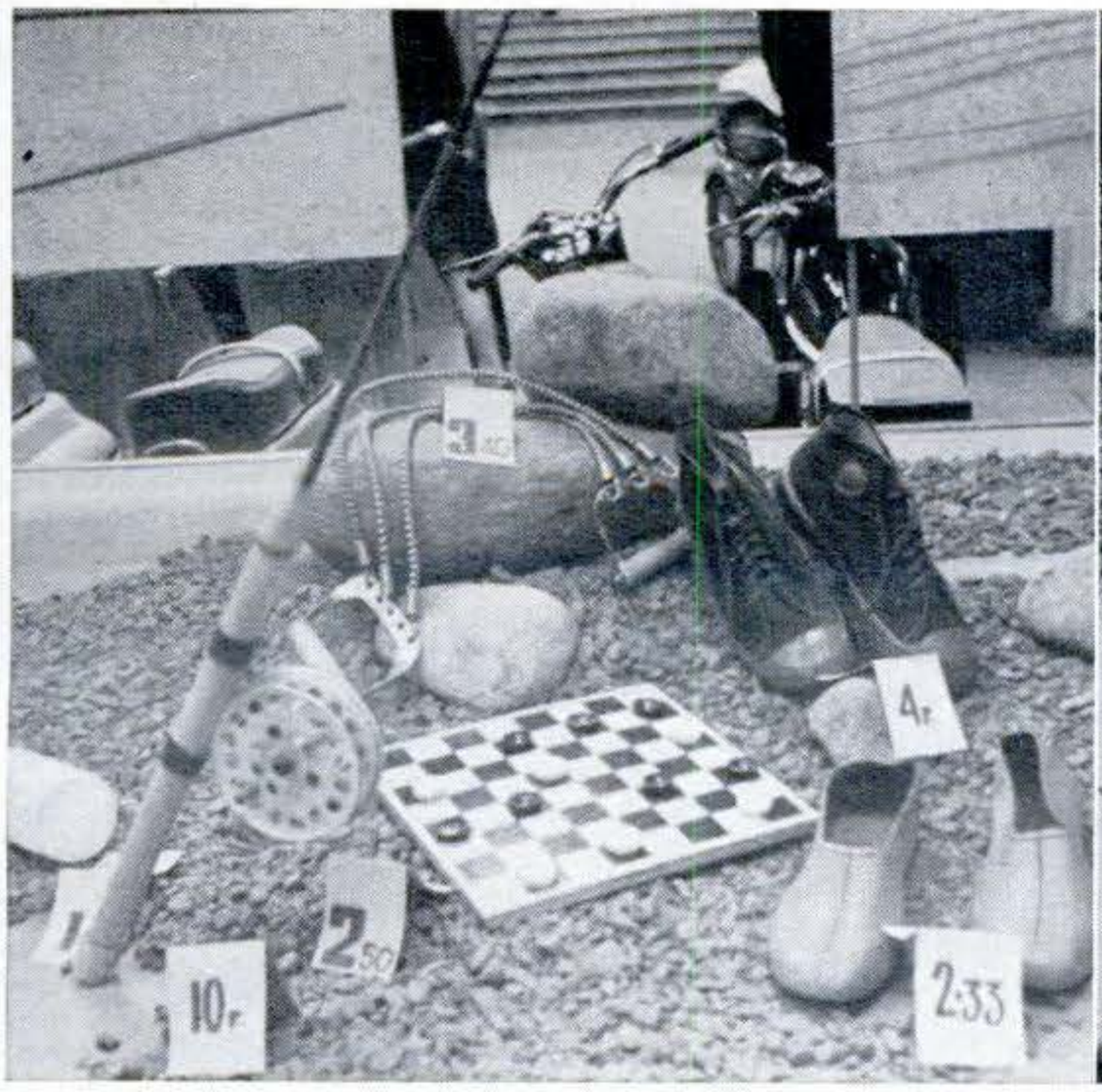
Fishing lures, part of large sporting-goods display at Leningrad *univermag*—department store—ranged widely in price. Fishing is a popular pastime.

Refrigerators draw lots of lookers, but delivery time is long. The sign above this six- or seven-cubic-foot model says: "SAMPLE—NOT FOR SALE."

Motor scooters, handsomely designed, carry price tag of 350 rubles. But author saw no scooters on streets of six cities he visited, few motorcycles.

Motorized bike offers both pedals and auxiliary motor. It's ticketed at 190 rubles. Other mo-peds, actually just bikes with motors hooked on, sold for 125 rubles.

Bikes (about 50 rubles) are popular, with a good selection (but no banana seats or hi-rise handle bars). Full parts stock indicated lots of "fix-it-yourselfers."



Leisure-time gear (above and at right) runs a mixed-up gamut in this shot through *univermag* window: from checkers and table tennis through exercise springs and skin-diving gear: fins snorkel tube, and spear gun. Scuba gear was not seen anywhere; nor was boating equipment, with few exceptions.

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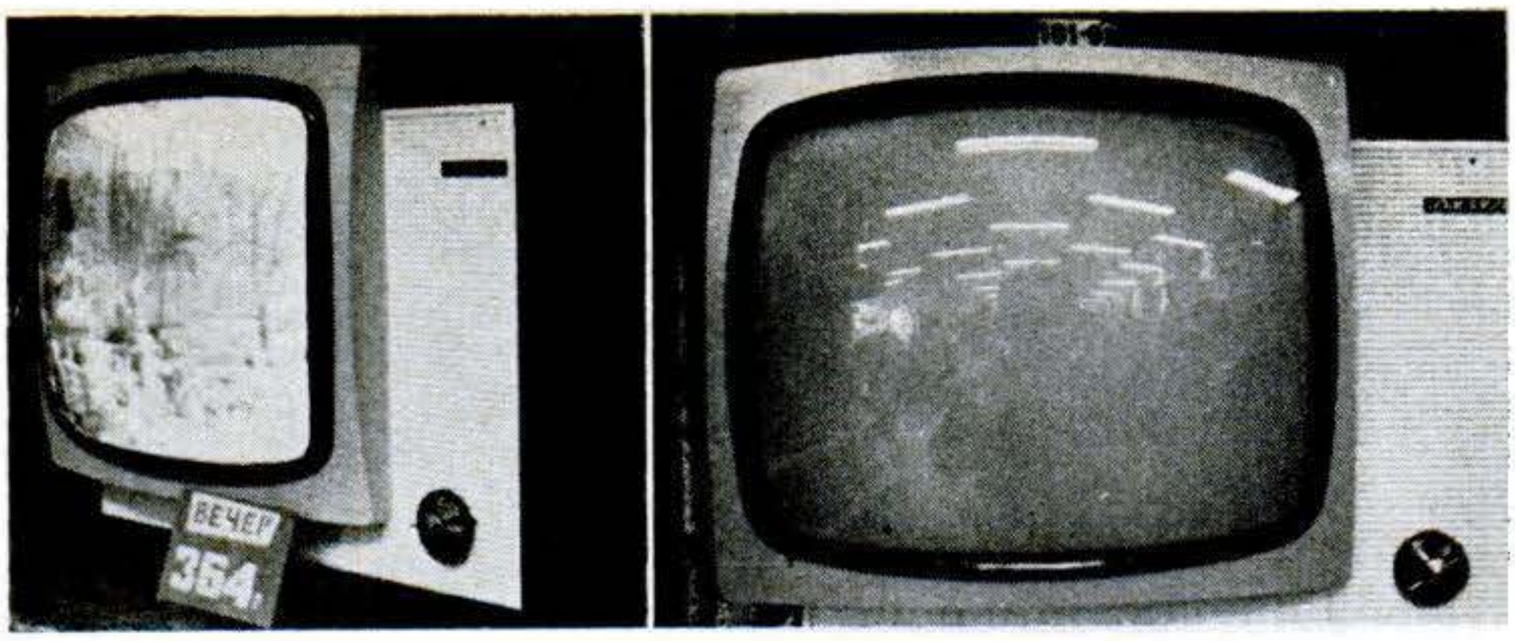
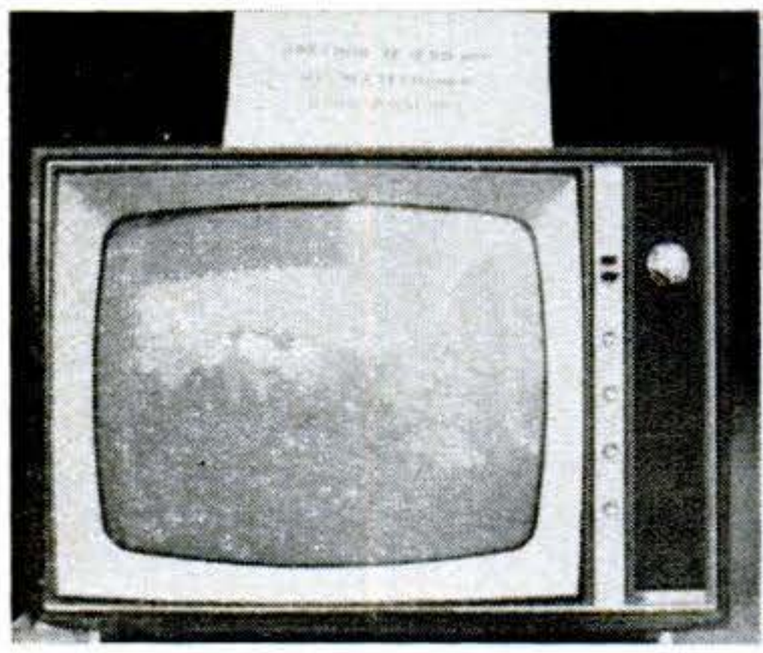
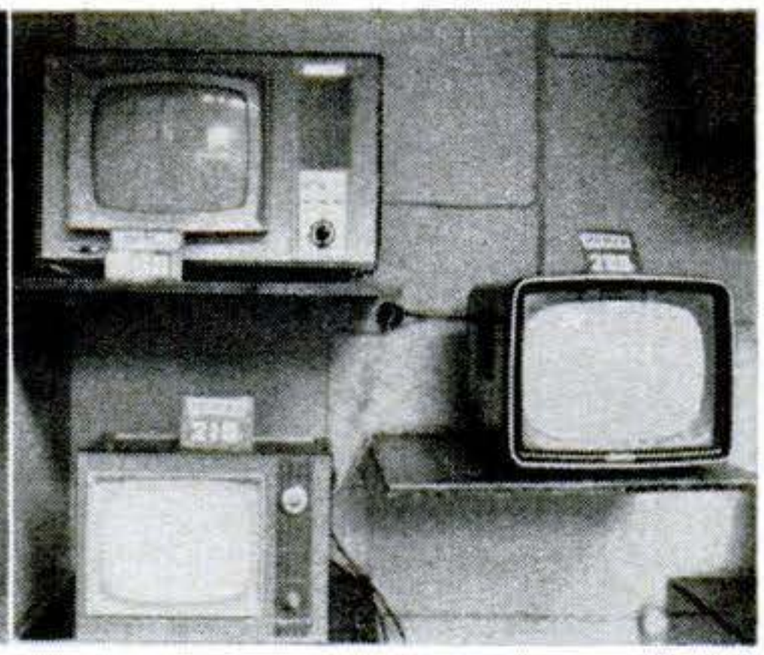


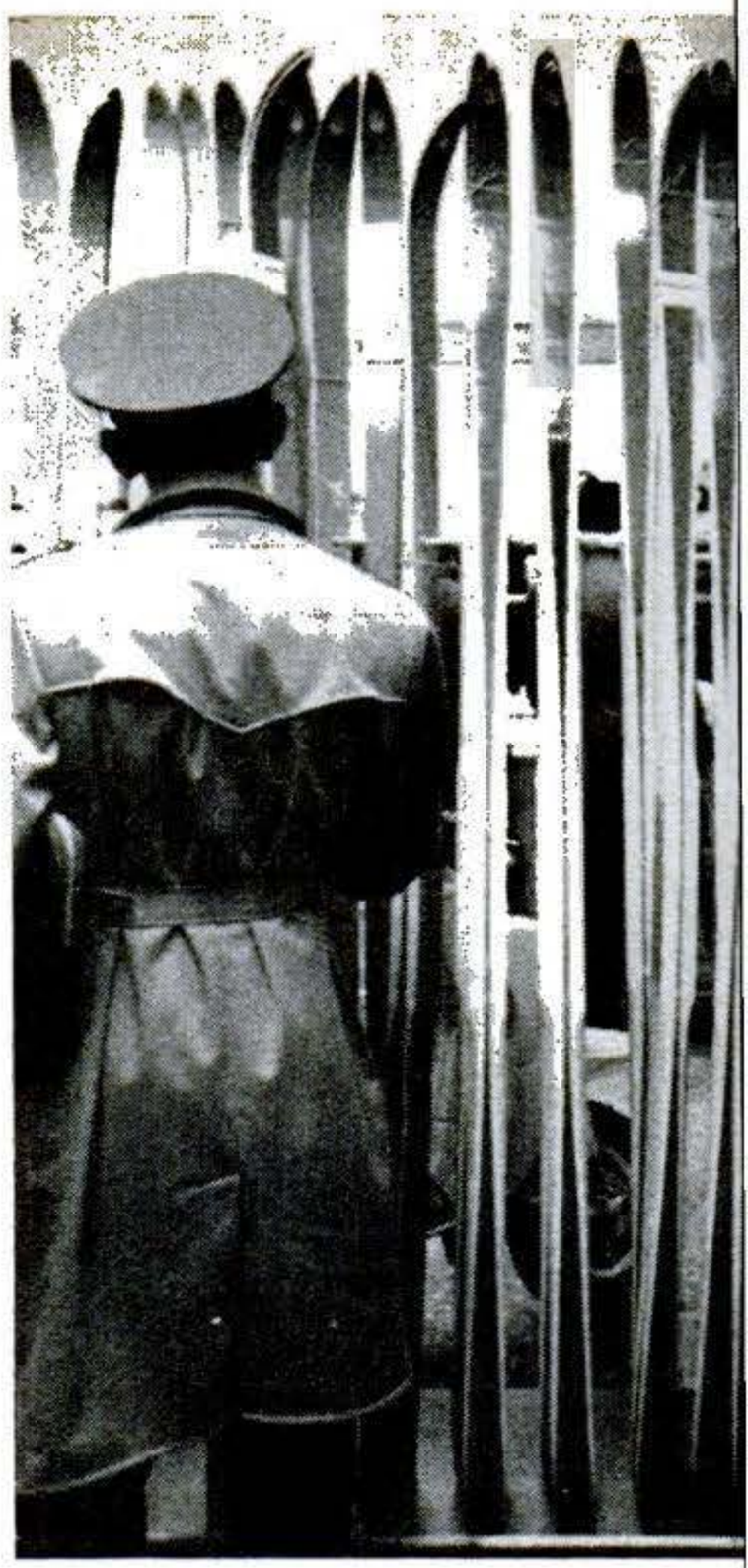
TV, one of hottest Soviet consumer items, has delivery time of a year, author was told. Model at left (about 17-inch), tagged at 364 rubles for average customer, sold for 101 rubles, 90 kopeks (right), in "foreign-exchange" store where only foreigners (with their own currency) or Soviet citizens with either foreign currency or "certificates" may buy.



Color-TV set was on display in exhibition outside Moscow. It was not turned on, nor is any color TV now being broadcast in USSR. Guide forecast color for 1969 or '70.



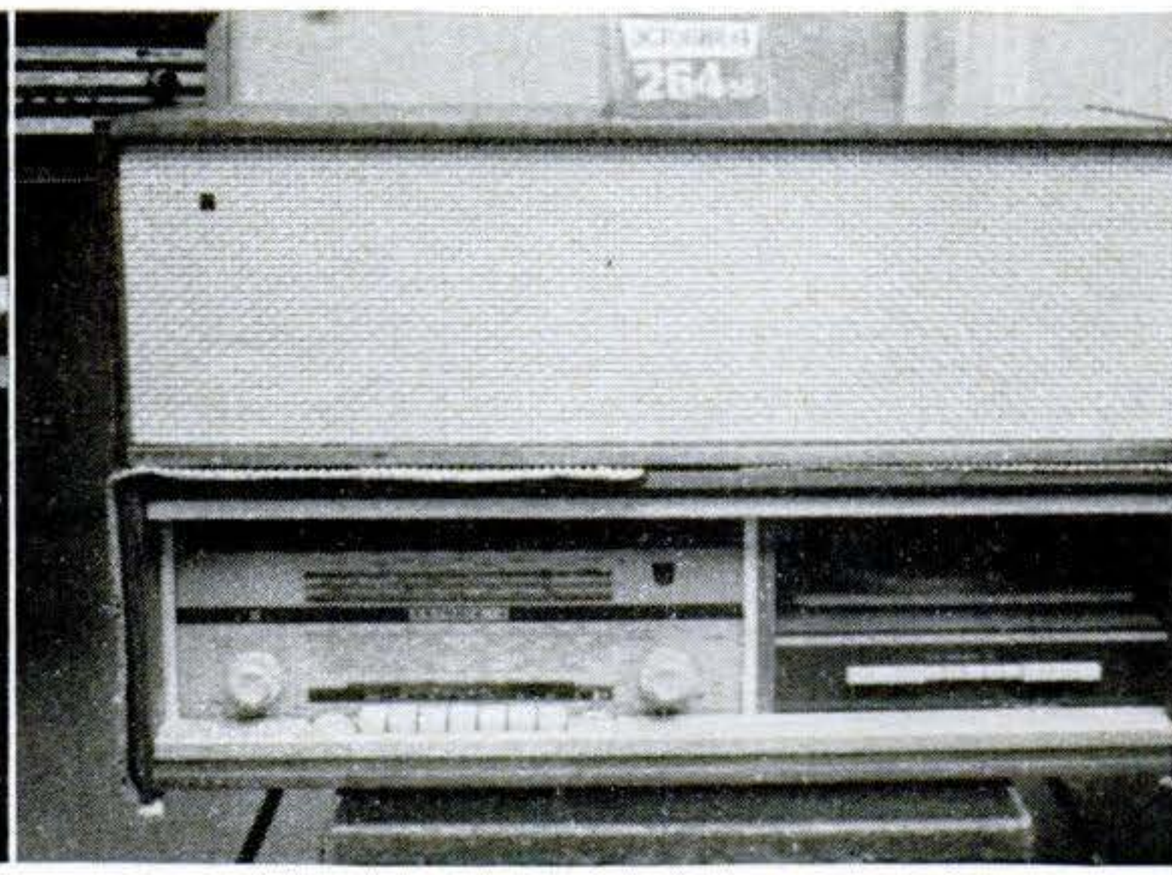
Smaller TV sets bring smaller prices—except for that one at upper left, for 900 rubles. Is it a color set? No one in store could speak English, to tell author.



Skis get a careful inspection above by a Soviet officer. They're slimmer than the ones commonly used in the U.S. Price tag on the pair fourth from right says 12 rubles.

WINDOW-SHOPPING IN RUSSIA Continued

you must know how much an item costs in terms of the buyer's earnings and *available* money to spend on it. Here's a brief rundown: The official Soviet exchange rate for rubles is $1.11 per ruble. (The black-market rate—and there *is* a black market in money—is a quarter of that or less. But let's think official.) Think of a ruble as being worth about a dollar. The average



Radio-phonographs are popular in USSR, and records are a big business, with recording quality excellent. Large units all have short wave. Short wave permits Soviet broadcasters to cover huge areas with few stations—but also lets listeners tune in to other European stations or even Voice of America.

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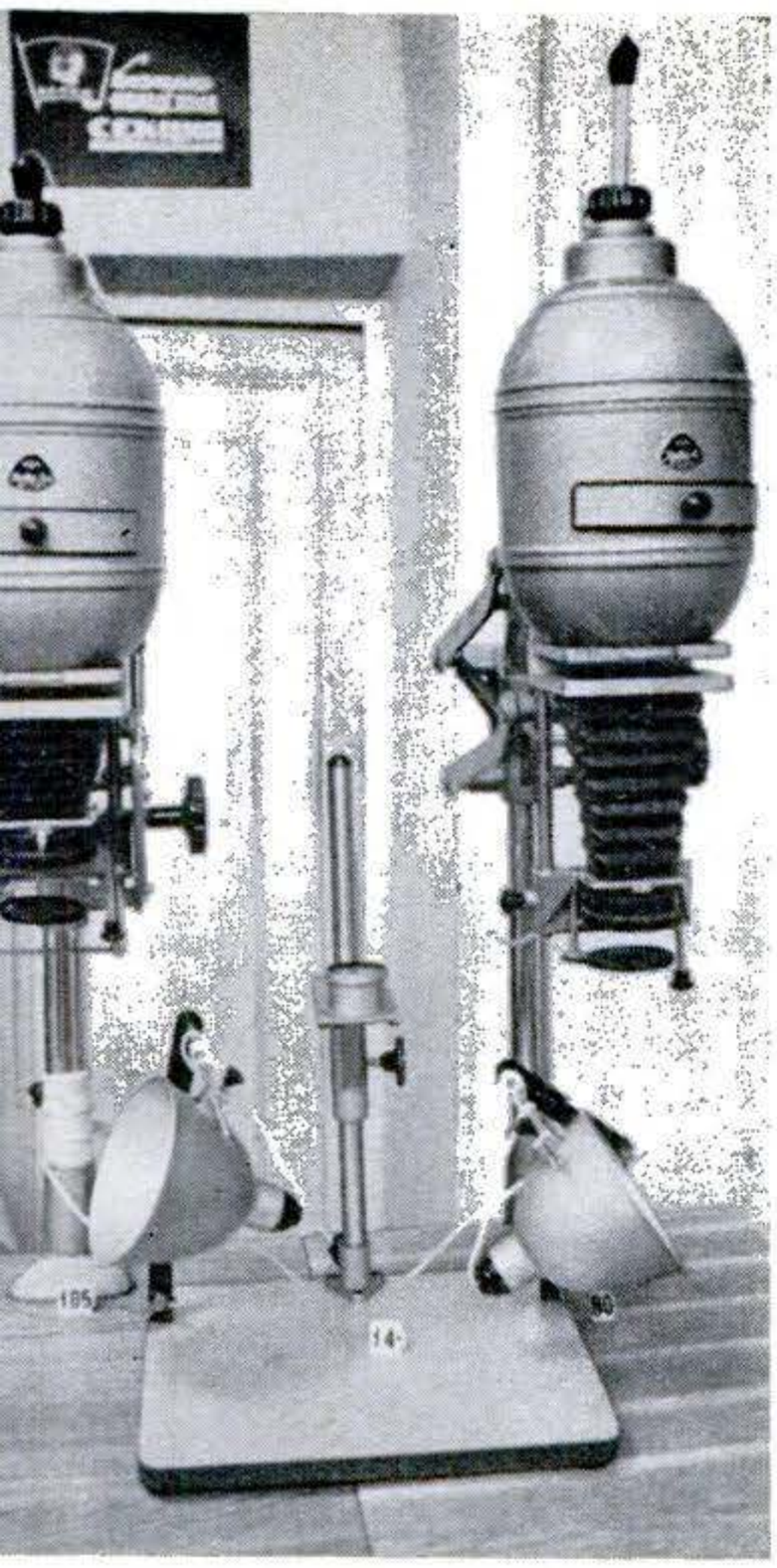
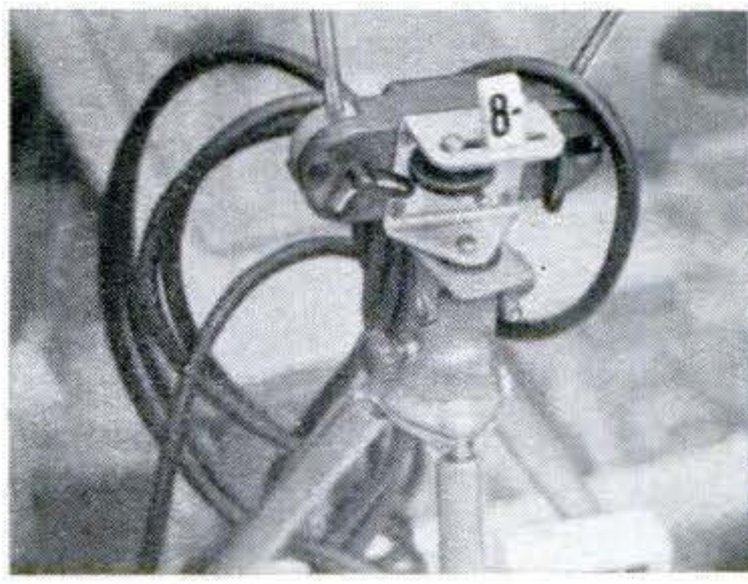


Optical goods above were part of display in a Leningrad store. Janpol enlarging lens with built-in color filters (bottom left) is also sold in the U.S.



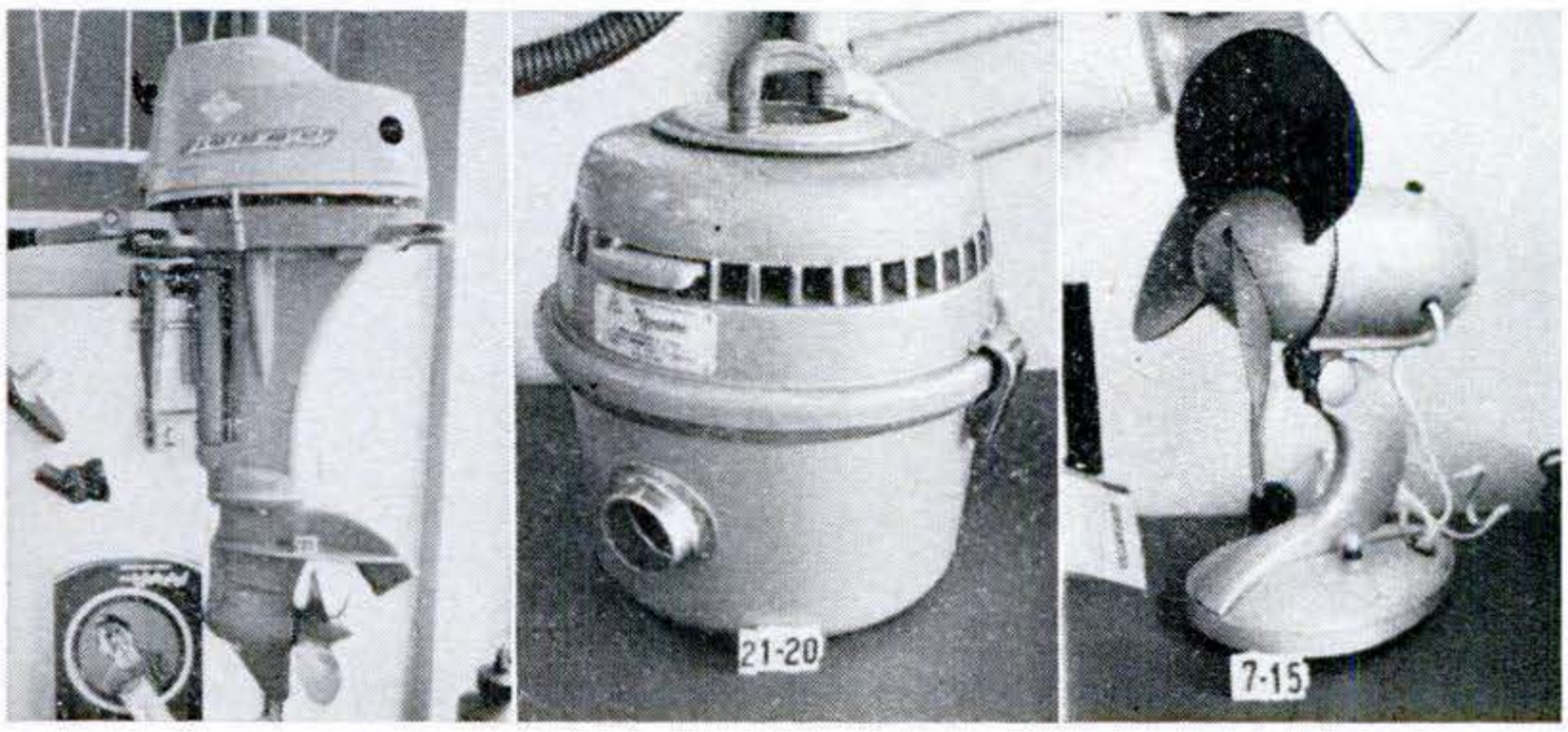
Enlargers, at 105 and 80 rubles, had filter drawers under condensers, presumably for color printing. Sturdy close-up stand, shown in center, is reasonable at 14 rubles.

Tripod accessory, screwed to head, holds arms for floodlight units. Loosening wingnuts lets you swivel floods to any height. A clever idea —but head is crudely designed.

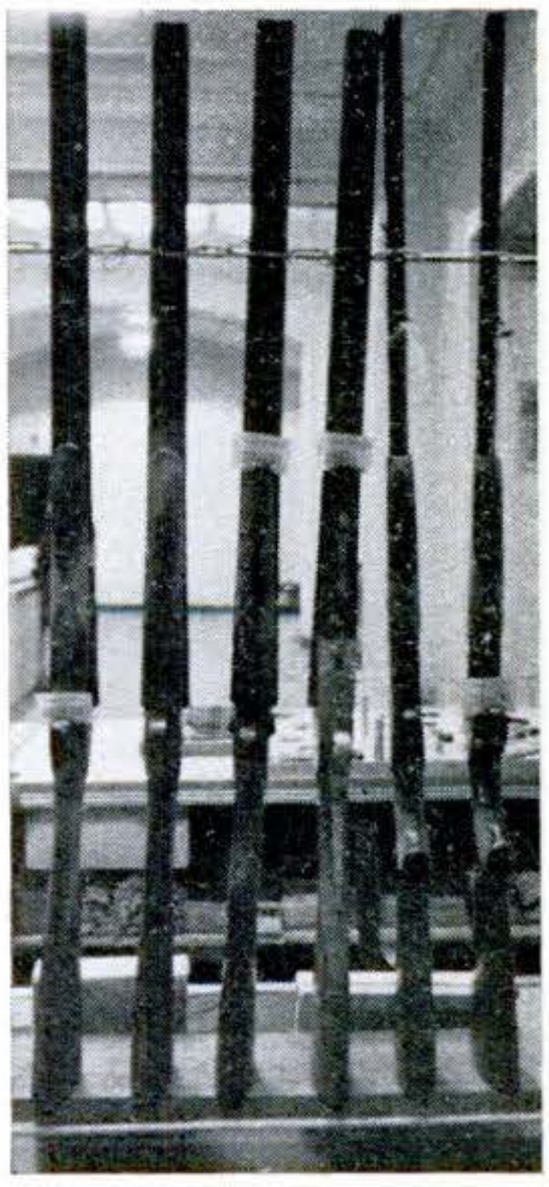
Electric-eye camera, fully automatic, has exposure meter ringing the lens. Similar design is still sold in U.S. but is now less popular than formerly. It's 100 rubles.

Soviet worker earns about 120 rubles a month, I was told—perhaps a quarter of the earnings of the typical American worker. So those ruble prices you see on the pictures here should be considered in light of an average weekly income of less than 30 rubles. Modifying that somewhat is the fact that rent and utili-

[Continued on page 226]



For privileged customers, these and similar luxury items are available at low prices in "foreign-exchange" stores. Walls are lined with unrelated objects, like the outboard motor at left, with vacuum-cleaning tools and an English-made ignition device behind it; a vacuum cleaner extraordinarily like a U.S. Lewyt cleaner of 15 or so years ago; and the rubber-bladed fan at right.



Shotguns and hunting gear get prominent display. Double-barrel guns run from 55-180 rubles; singles, 21 rubles up.

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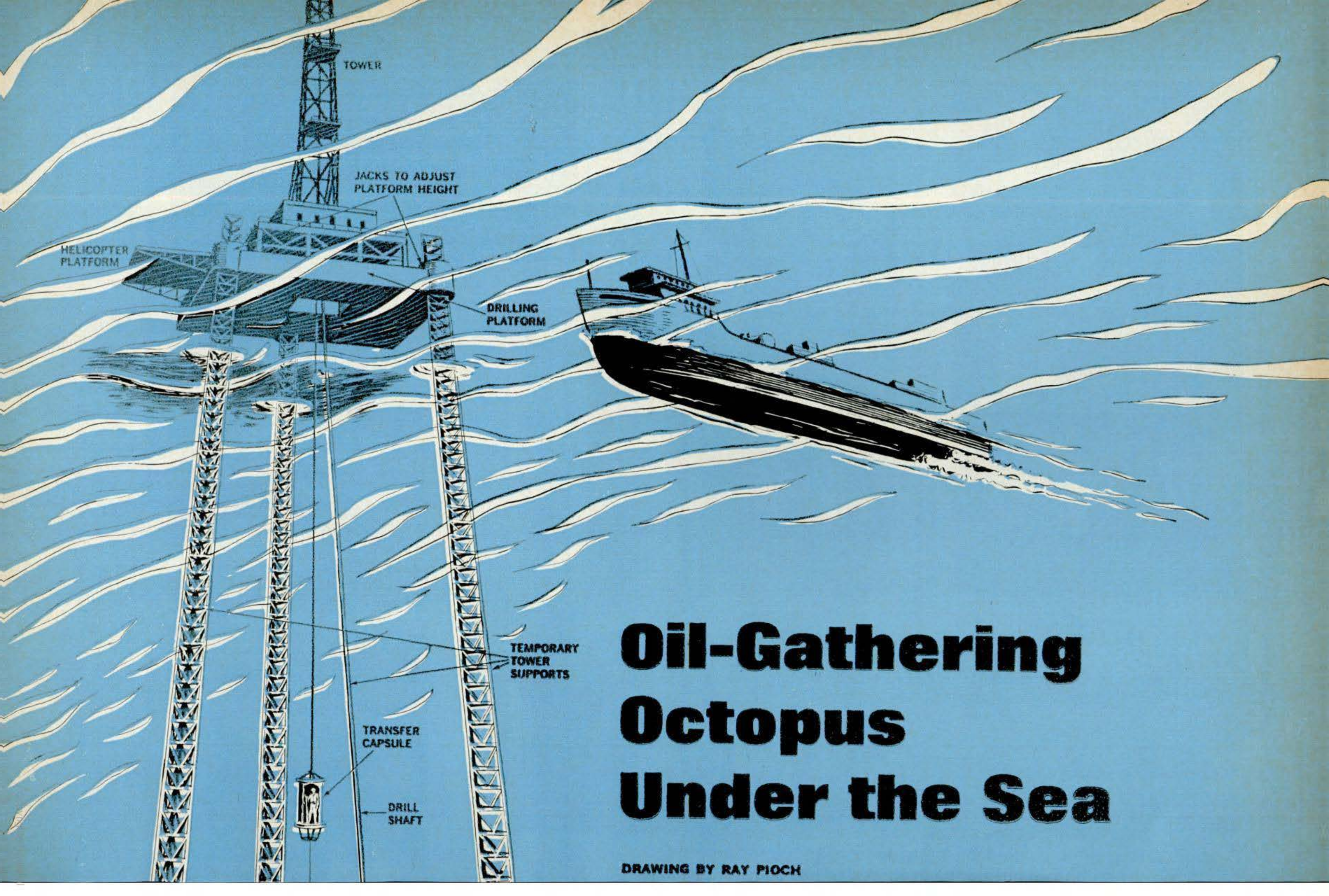
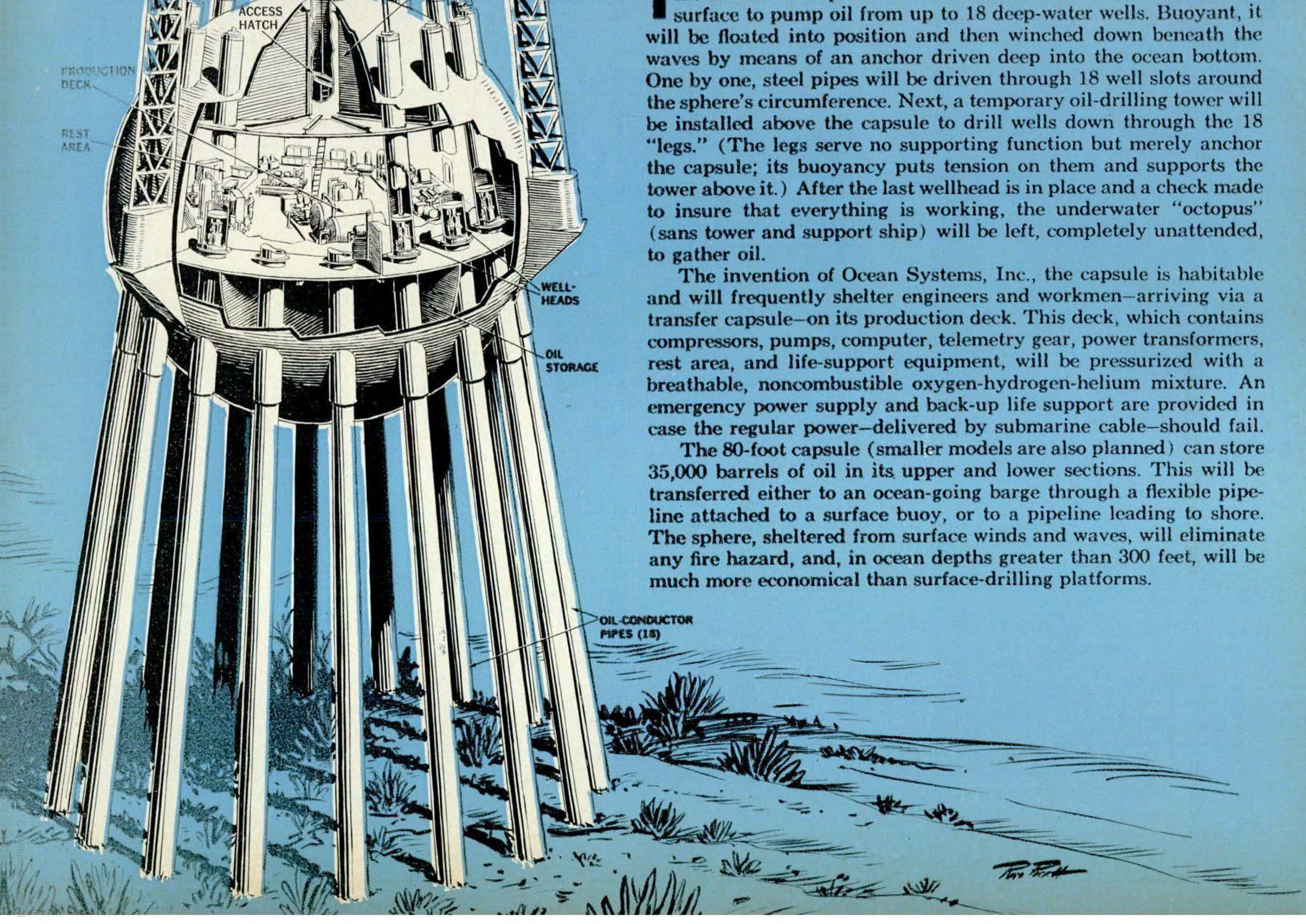


Oil-Gathering Octopus Under the Sea

DRAWING BY RAY PIOCH



surface to pump oil from up to 18 deep-water wells. Buoyant, it will be floated into position and then winched down beneath the waves by means of an anchor driven deep into the ocean bottom. One by one, steel pipes will be driven through 18 well slots around the sphere's circumference. Next, a temporary oil-drilling tower will be installed above the capsule to drill wells down through the 18 "legs." (The legs serve no supporting function but merely anchor the capsule; its buoyancy puts tension on them and supports the tower above it.) After the last wellhead is in place and a check made to insure that everything is working, the underwater "octopus" (sans tower and support ship) will be left, completely unattended, to gather oil.

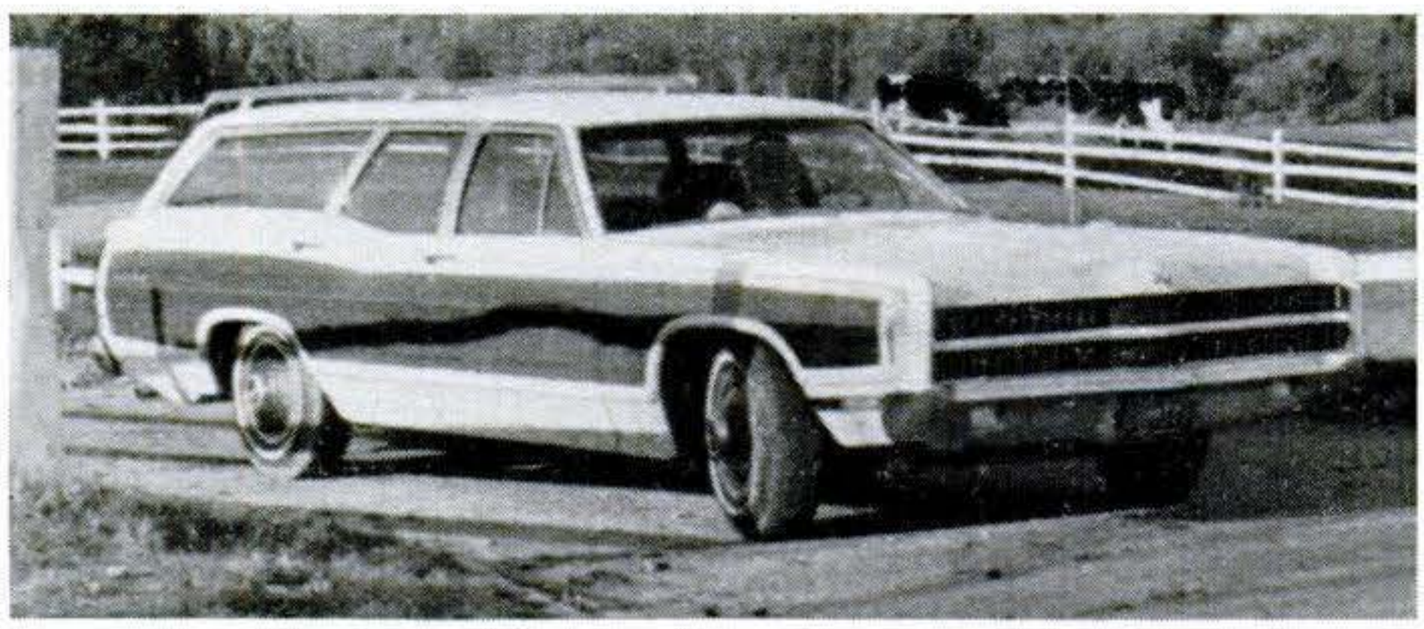
The invention of Ocean Systems, Inc., the capsule is habitable and will frequently shelter engineers and workmen—arriving via a transfer capsule—on its production deck. This deck, which contains compressors, pumps, computer, telemetry gear, power transformers, rest area, and life-support equipment, will be pressurized with a breathable, noncombustible oxygen-hydrogen-helium mixture. An emergency power supply and back-up life support are provided in case the regular power—delivered by submarine cable—should fail.

The 80-foot capsule (smaller models are also planned) can store 35,000 barrels of oil in its upper and lower sections. This will be transferred either to an ocean-going barge through a flexible pipeline attached to a surface buoy, or to a pipeline leading to shore. The sphere, sheltered from surface winds and waves, will eliminate any fire hazard, and, in ocean depths greater than 300 feet, will be much more economical than surface-drilling platforms.

The wagons line up, and the gasoline tanks are filled, oil checked, tire pressure adjusted, a

Big Wagons Carr

Filling the gap between sedans and pickups, the '69 wagons tempt you with new tailgate and third-seat options, more luxury, more power



FORD: Country Squire rates first for best wagon-type features.

PLYMOUTH: Sport Suburban packs willing, but thirsty, engine.

By JAN P. NORBYE
PS Automotive Editor

and JIM DUNNE
PS Detroit Editor

What you're looking at here are the best-selling full-size wagons on the market—yet not one of them was designed as a wagon from the ground up. They're really sedans with a different type of body in back of the rear seat. You can't even say it's a utility body, because some of them are dolled up with simulated wood-grain panels and other fancy decorations.

These wagons are great dual-purpose vehicles. They can carry most of the cargo a family needs on a long trip or wants to bring home from a shopping spree—the

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PHOTOS BY ORLANDO GUERRA

dows made sparkling before cars are driven to Bridgehampton track for performance tests.

ids and Cargo in Style

roceries, garden supplies, new furniture, r plywood panels and sawhorses. The ame wagons can also serve as passenger ars, and the owners need make no apolo- ies when parking at the country club.

If you're looking for more wagon" than you get n these vehicles, you hould look at a Wagoneer Kaiser Jeep), GMC Sub- rban, or a Travelall (In- ernational Harvester), the ne based on a rugged four- heel-drive workhorse, the thers on pickup trucks.

We went for optional bigger) engines, matched n performance to Pontiac's 28 V-8. You need lots of orque if you're going to se the full carrying capac- y of these wagons, and ou're not gaining much conomy if you go for any- hing smaller. Tests have hown that gas mileage is ictated mainly by vehicle eight and frontal area— ot by engine size and rat- d horsepower.

A smaller engine can ac- ually burn more gas than a big one if the car is so heavy that the small engine is "overloaded." In this test, the car with the smallest engine re- turned the poorest fuel economy!

With these great engines, disk brakes,

Continued

CHEVROLET: Kingswood rides and drives just like a sedan.

PONTIAC: Catalina is tops in both acceleration and economy.

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and heavy-duty suspension, the wagons proved to be tremendous highway cars. Partly flooded roads and 60-m.p.h. crosswinds didn't bother them a bit. They kept going where you steered them, and stopping ability was unimpaired by any number of splashes.

On the other hand, the vast interiors take time to heat up, and fogging of the side and tailgate windows is a serious problem. Side windows at the rear cannot be opened—they're fixed in place. During damp weather these windows steam up, creating a huge blind spot that blacks out important areas of vision. Heating wires in tailgate and side windows should be standard on wagons.

The rear compartment catches water like a rain barrel if the rear window kept just a little bit open in the rai During this test, three of the wagons ha water sloshing in the back, from thre different rainstorms.

Some rain just falls in, but there's als the runoff from the roof. Even if it ha stopped raining, water on the roof run inside when you move off. Surprisingl none of the wagons had a drain plug i the floor.

Rear seats are not easily moved to up right or stored position. It takes som muscle. That's not too bad, but on th Plymouth you must crawl inside o hands and knees to get at the movabl panels. The hand holds—and this goe for all of them—are not as easily grippe

With dual/facing third seat set up, youngsters in the back of the Ford have a convenient play table on long trips. Table is over the rear axle.

When third seat is folded in the Ford, a larg area with a flat floor is created—an excellent pla pen for corralling children behind the second sea

Step height to third seat in Plymouth is a problem for youngsters' short legs. Tailgate handle is small and inconvenient; third seat faces backward.

On both sides of third-seat passengers in Plymout are storage boxes in window sills—a great conver ience for books, games, or between-meals snacks

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ıd third-seat arrangement than GM

as they could be. Seat releases are not clearly identified, and may puzzle new owners.

Spare tires are stored upright, behind the right-rear wheel housing, covered by easily removable panels. This space would otherwise be wasted.

These are big wagons, and their very size will make for parking problems. But let's look at them by brand:

Chevrolet has a two-way tailgate for the first time, and the rear bumper has a low step in it to make getting in and out easier. We were impressed with the wagon's overall quality, total absence of rattles, and lack of fuss.

Performance was excellent—the 427-cubic-inch V-8 has the free-breathing "porcupine" cylinder heads that were developed for the 396 four years ago. But the brakes were somewhat disappointing. The new single-piston floating-caliper disk brakes had no fade problems in the hardtop tested last month, but faded after eight warmup stops in the wagon.

Two endearing details on the Chevy are the vinyl side moldings for body protection in tight parking places, and the hangers provided for the seat-belt buckles in the third seat.

Ford wagons now have a rear "doorgate" that can be opened and closed with the window in the up position. This is especially helpful on rainy days. You don't get wet, waiting for the window to come down before you can open up. The handle is on the outside of the doorgate, where it's most convenient for a good hold without blind groping on the inside.

All in all, you get the impression that before Ford designed the tailgate version of their full-size car, they spent a little more time thinking about wagon usage than did GM and Chrysler.

When tailgate is opened on the Pontiac, a section of the bumper goes with it to make a low step. The Chevrolet shares this Fisher Body feature.

The brakes on the Country Squire differ from those on the Galaxie. The single-piston floating caliper is the same, but Ford wagons are equipped with a double-diaphragm brake booster, and the rear drums are flanged. These modifications certainly paid off in our test, for the wagon stopped shorter and with less pedal effort than the hardtop!

Plymouth has a wagon body that boasts two new built-ins this year: an integral air deflector that really works, and a series of "flower-box" compartments alongside the rear windows.

The tailgate has Chrysler Corp.'s exclusive wash-and-wipe system. Actually, the built-in air deflector does such a great job of keeping the tailgate window clean that this feature is less needed on a Plymouth than on wagons with other types of air deflectors.

The two-way tailgate handle is small and inconveniently placed on the inside,

Continued

Air deflectors above tailgate windows are standard on Plymouth (center), optional on Ford (right) and Chevrolet (left). During PS tests, the Plymouth always had the cleanest tailgate window, while the Ford developed wind noise around the deflector. Pontiac (top of page) has same deflector as Chevy.

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Rubber cones mark lane 12 feet wide for brake test. Eight pairs of cones spaced 30 feet apart along track give a 210-foot run for the final stop. One wagon overshot grid because of brake fade.

below the top ledge. From outside, you fumble until you find it, then try to remember which way to push it to open the tailgate in the position wanted.

The only step to the third seat is on the top of the bumper, which is much too high for the youngsters who usually sit there. As for the third seat itself, it's a lot of bother to set up. First you have to reach far into the middle of the car and lift a forward floor panel.

The Sport Suburban had the longest stopping distance we've yet encountered. A Chrysler car with the earlier Budd four-piston fixed caliper still holds the record for *short* stopping distance (among full-size cars). For '69, Chrysler Corp. switched to the Kelsey-Hayes single-piston floating-caliper disk brake. It doesn't do the job nearly as well.

Pontiac has the same two-way tailgate, low bumper step, and vinyl side moldings as Chevrolet. Interior dimensions are almost identical. But the Catalina gave us more performance and better fuel economy than the Chevy wagon.

How does Pontiac do it? Without extensive redesign, their first-generation V-8 from 1954 has been enlarged and developed to where it breathes better, takes a higher compression ratio, and burns fuel more efficiently than the most advanced power unit Chevy has come up with.

The Catalina wagon has all the usual features you're used to on Pontiac passenger cars: variable-ratio steering, good-size tires as standard, rubber front bumper, noisy but effective wipers, vinyl-covered steering wheel, distinctive styling.

Conclusions

DUNNE: I'll pick the Ford. Its size and roominess, facing rear seats, and window-up rear-door operation are plus points that count heavily when you're shopping for a wagon.

NORBYE: My vote would go to the Pontiac—if I wanted a wagon that is fun to drive. But since you're usually looking for other values, my choice is the Ford, too, mainly for its tough brakes and balanced high-speed handling. PS

Chevy stopped in reasonable distance, but brakes were smoking as wagon came to a full stop. Dunne (at wheel) and Norbye measure stopping distance.

In lane-change test, Ford showed great stability and adequate response, despite slow steering ratio. All wagons tested had heavy-duty suspension.

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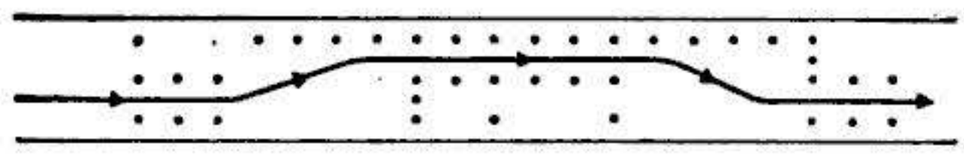
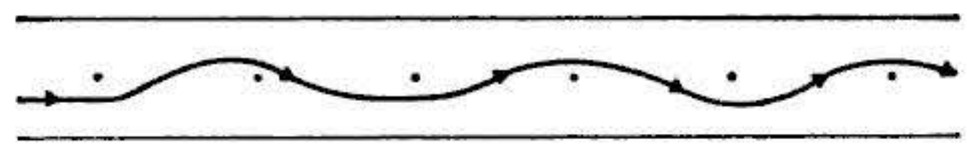
How PS tests cars—and what our tests are intended to show

BRAKES This test shows a car's ability to stop in a straight line after repeated stops (as in stop-and-go highway traffic). Ten warmup stops from 60 m.p.h. at one-minute intervals with half-g (16 feet per second per second) are followed by a final stop for minimum braking distance without wheel locking in a 12-foot-wide lane. Pedal pressure is recorded on all stops. Excessive pressure indicates fade.

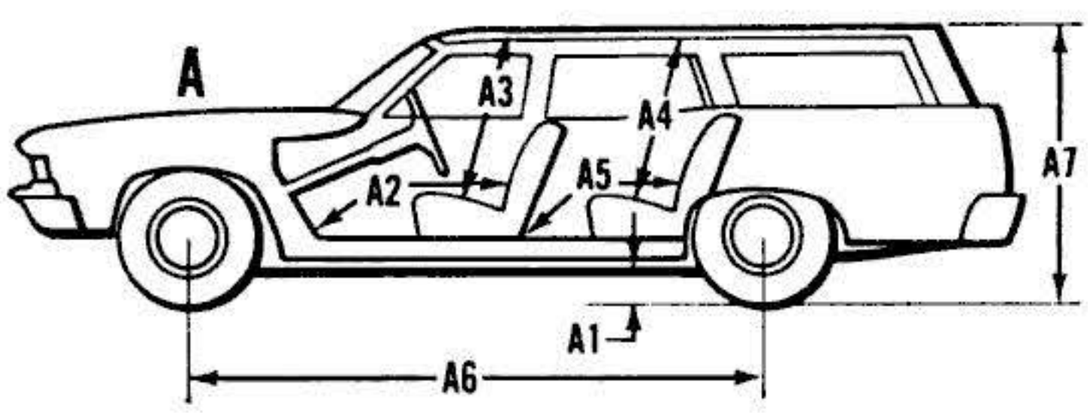
ACCELERATION The 0-60-m.p.h. test shows a car's ability to reach cruising speed from standstill; 0-80 test shows its high-speed power reserve; 25-70 m.p.h. test simulates a highway merging situation or passing on a two-lane road. In all tests, the car is in Drive.

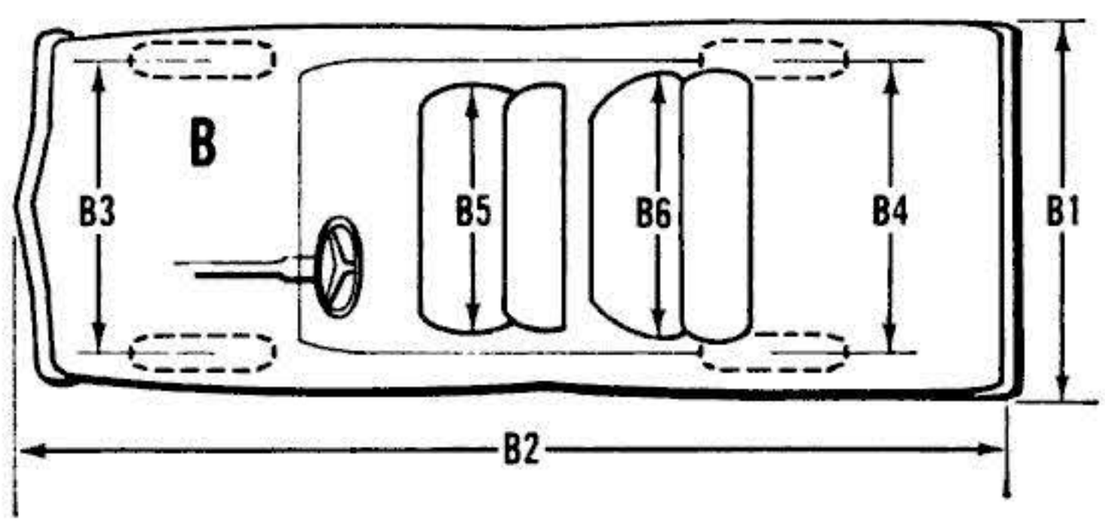


LANE CHANGE Two lane changes in quick succession show a car's ability to make an emergency maneuver at high speed. The lanes are blocked 120 feet apart, and each lane change must be completed within 60 feet. Each car is put through the test at increasing speeds until its maximum is established.



MANEUVERING Snaking a car as fast as possible through pylons spaced 48 feet apart shows its ability to negotiate narrow, winding roads or heavy city traffic where sharp turns are needed to avoid a stopping bus, double-parked truck, or car pulling out from the curb.





DIMENSIONS (inches)	CHEVROLET Kingswood	FORD Country Squire	PLYMOUTH Sport Suburban	PONTIAC Catalina
A1 Ground clearance	6.4	6.5	7.2	6.0
A2 Front leg room (max.)	41.4	42.1	41.8	41.5
A3 Front head room	39.0	39.4	39.6	39.2
A4 Rear head room	38.8	39.6	40.2	39.0
A5 Rear leg room (min.)	37.1	37.1	39.4	38.2
A6 Wheelbase	119.0	121.0	122.0	122.0
A7 Height	56.9	56.8	58.1	56.0
B1 Width	79.8	79.8	79.6	79.8
B2 Length	216.7	217.0	219.1	220.5
B3 Front track	63.5	63.0	62.1	64.0
B4 Rear track	63.4	64.0	63.4	64.0
B5 Front hip room	63.7	62.3	63.3	63.8
B6 Rear hip room	63.0	62.4	63.4	62.9
SPECIFICATIONS				
Engine type	OHV V-8	OHV V-8	OHV V-8	OHV V-8
Bore x stroke	4.25 x 3.76 in.	4.36 x 3.59 in.	4.25 x 3.38 in.	4.12 x 4.00 in.
Displacement	427 cu. in.	429 cu. in.	383 cu. in.	428 cu. in.
Compression ratio	10.25:1	10.5:1	10:1	10.5:1
Carburetion	One 4-barrel	One 4-barrel	One 4-barrel	One 4-barrel
Power @ r.p.m.	335 @ 4,800	320 @ 4,600	330 @ 5,000	360 @ 4,600
Torque (lb.-ft.) @ r.p.m.	460 @ 3,200	460 @ 2,200	425 @ 3,200	472 @ 3,200
Transmission	Turbo HydraMatic	Cruise-O-Matic	TorqueFlite	Turbo HydraMatic
Axle ratio	2.56:1	2.80:1	3.23:1	3.08:1
Tires	Goodyear	General	Goodyear	Goodyear
Tire size	8.55-15	8.55-15	8.85-15	9.5-15
Turning diameter	43.6 ft.	42.3 ft.	43.5 ft.	42.8 ft.
Turns, lock to lock	3.75	4.1	3.55	3.9
Brakes	Disk/drum	Disk/drum	Disk/drum	Disk/drum
Fuel tank	24 gal.	22.5 gal.	22 gal.	24 gal.
Curb weight	4,818 lb.	4,733 lb.	4,610 lb.	4,929 lb.
TEST RESULTS				
Acceleration 0-60 m.p.h.	9.9 sec.	11.2 sec.	10.4 sec.	8.9 sec.
Acceleration 0-80 m.p.h.	17.5 sec.	18.45 sec.	16.9 sec.	15.0 sec.
Acceleration 25-70 m.p.h.	11.3 sec.	11.8 sec.	11.2 sec.	10.0 sec.
Braking distance 60-0 m.p.h.	169 ft. 7 in.	163 ft. 10 in.	211 ft.	203 ft. 11 in.
Brake pedal pressure	200+ lb.	80-140 lb.	200+ lb.	200+ lb.
Max. speed—lane change	55 m.p.h.	60 m.p.h.	64 m.p.h.	58 m.p.h.
Max. speed—traffic weave	26 m.p.h.	24 m.p.h.	26 m.p.h.	30 m.p.h.
Average fuel mileage	9.6 m.p.g.	9.9 m.p.g.	8 m.p.g.	10.4 m.p.g.
Price (basic)	$3,448	$3,721	$3,701	$3,647
Price (as tested)	$4,351	$4,816	$4,579	$4,887

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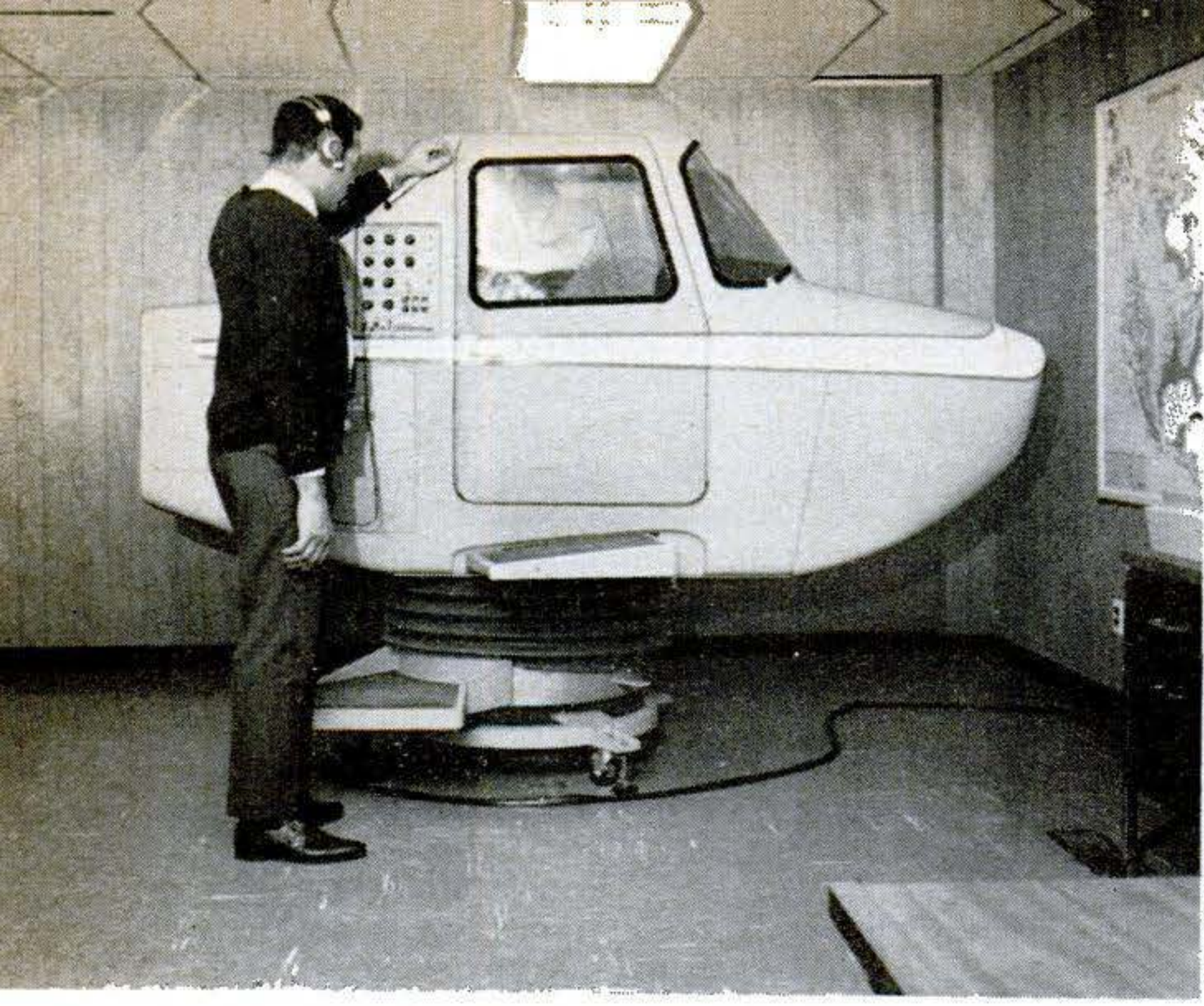
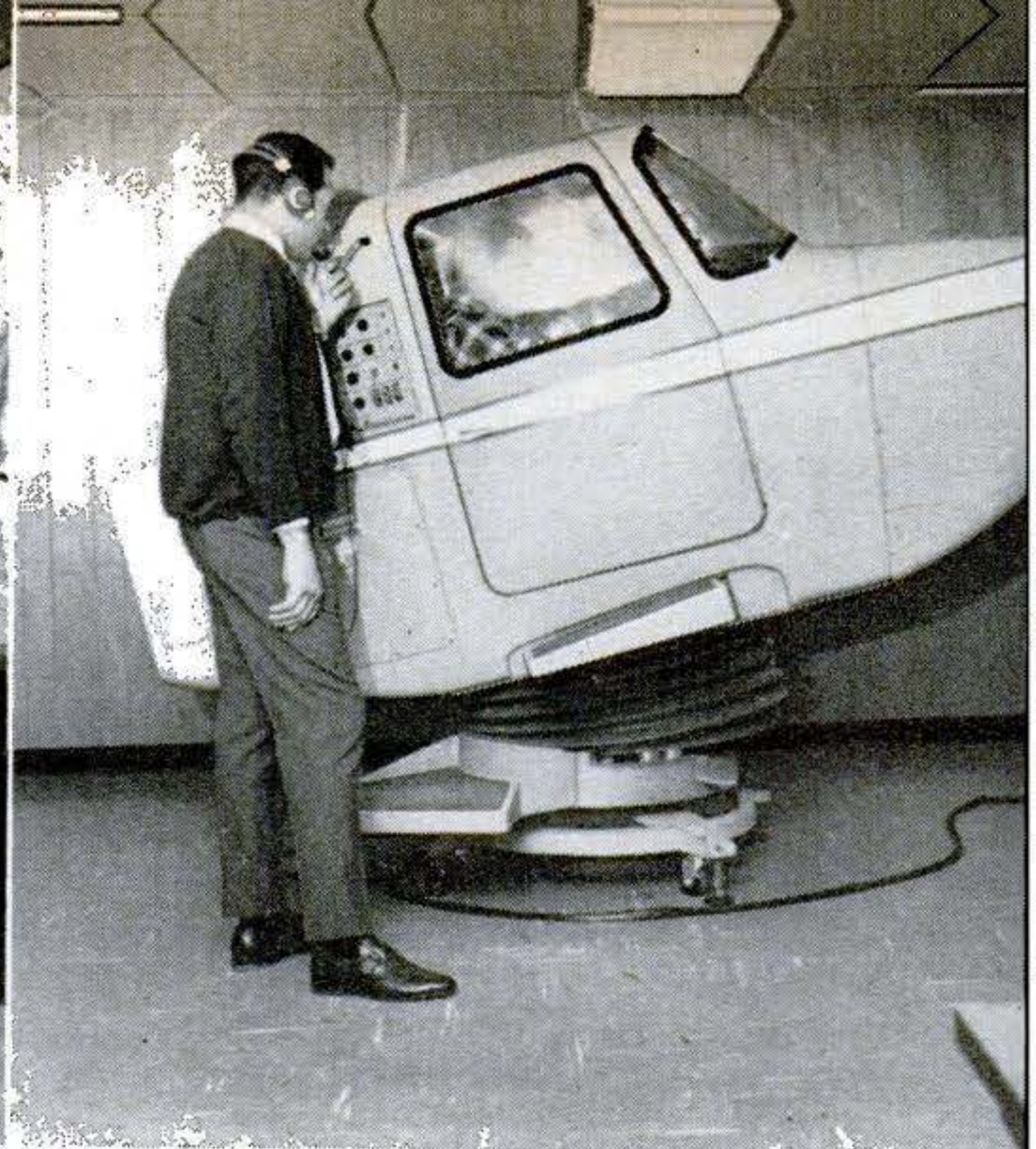


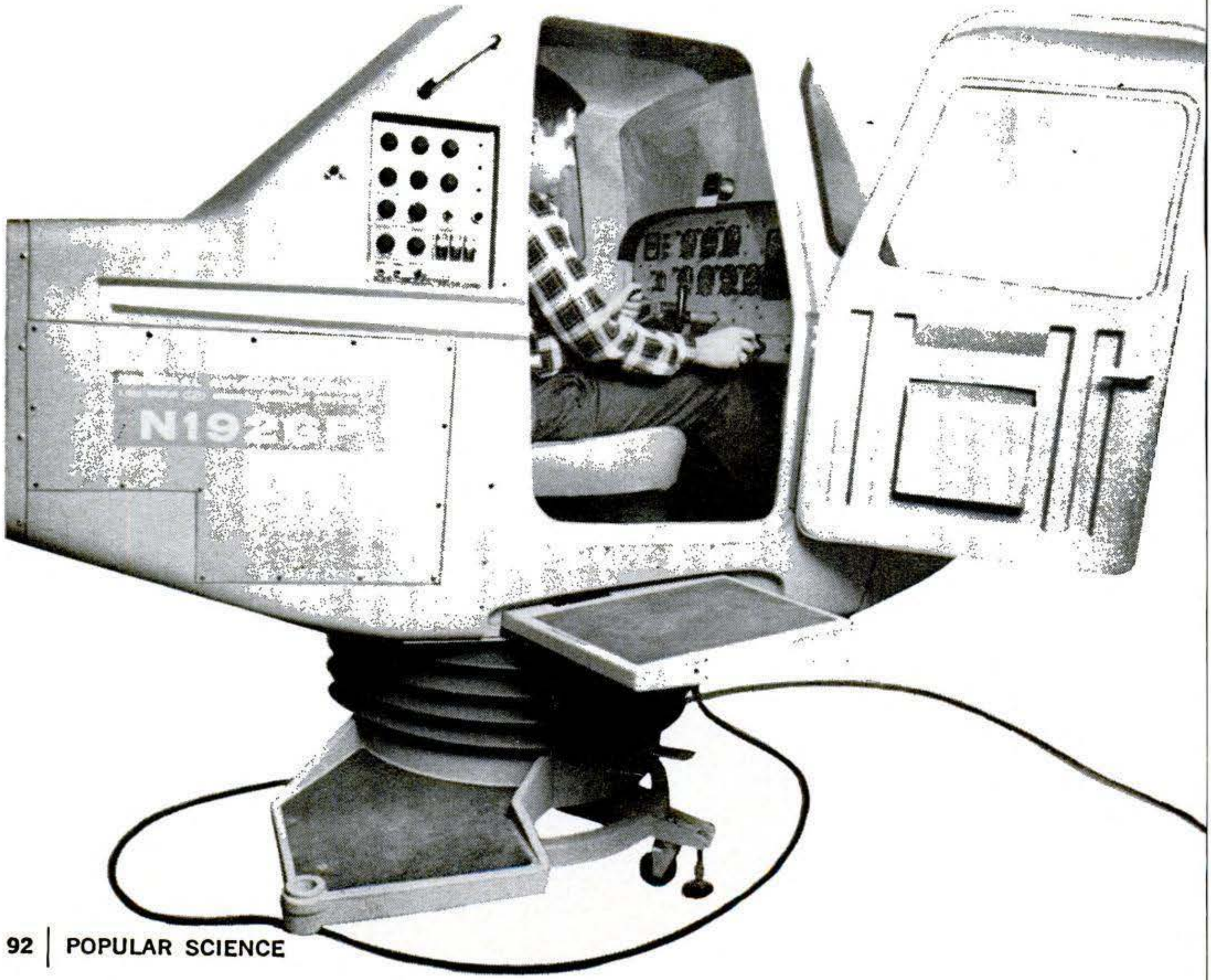
Takeoff. Sitting in simulator (instructor stands outside), I apply full power; "craft" begins to roll. At 60 m.p.h., I pull back on control column, and . . .



. . . **Climb.** The nose lifts, and the craft "climb at a relatively slow 500 feet per minute. My speed is slightly over 70 m.p.h. I'm ready for .

PS PRIVATE FLYING

I Learned to "Fly



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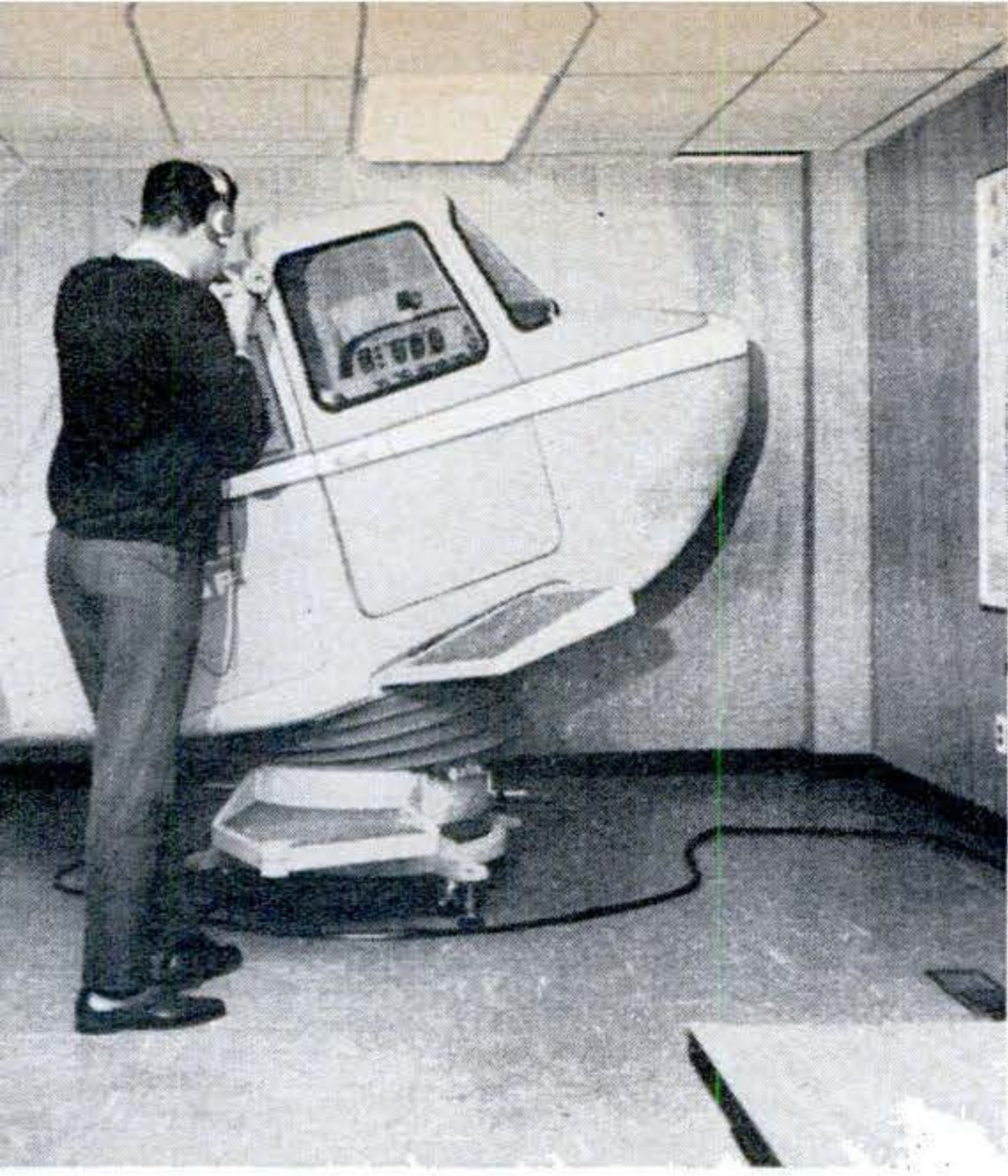
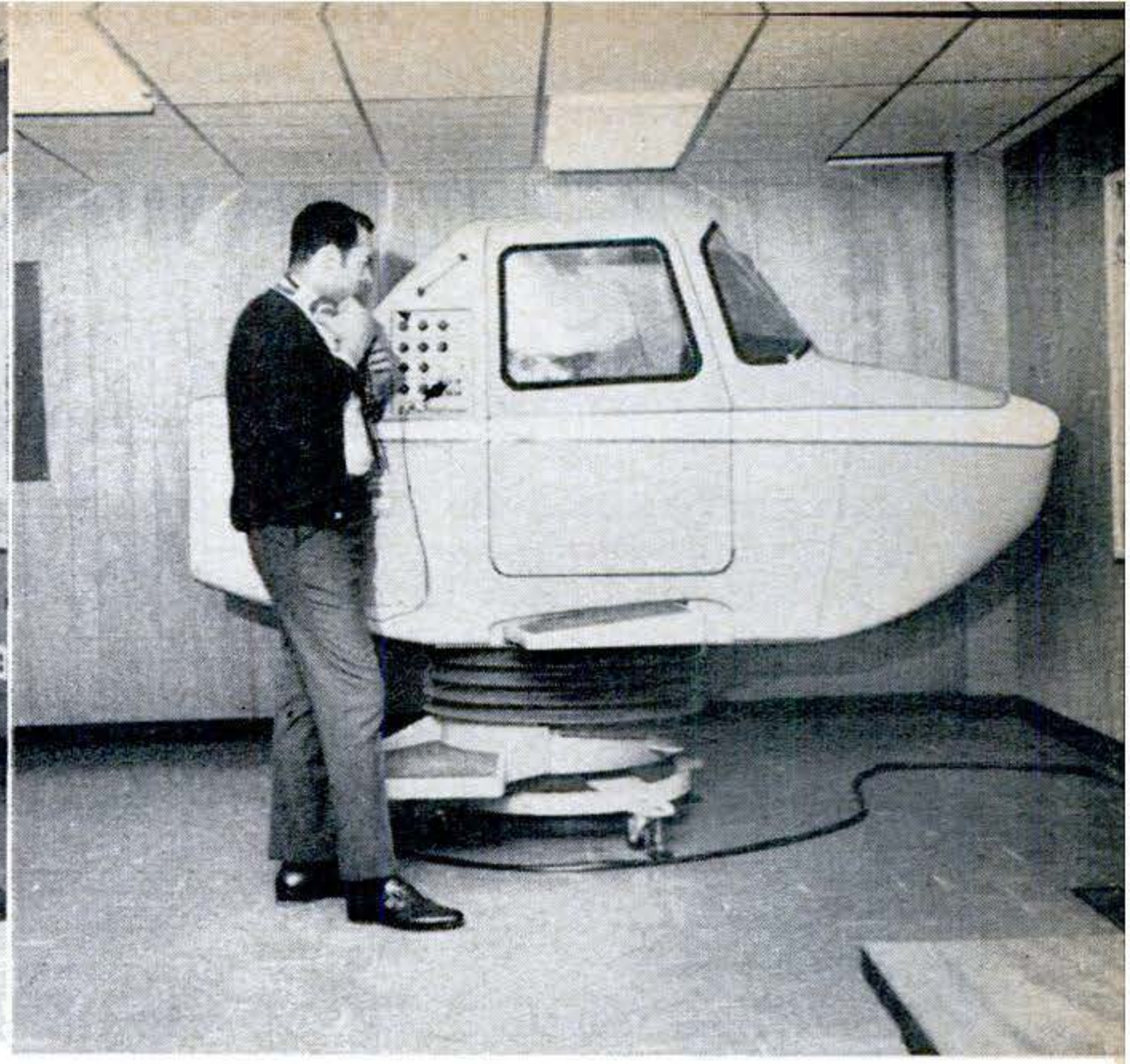


. . . **Leaving the pattern.** To get away from the airport's traffic pattern, I make a 90-degree turn to the left, then a 45-degree turn to the right, into . . .



. . . **Straight and level "flight."** I reduce engine r.p.m. to 2,400 (cruise power), "trim" the controls for level flight, and we're off! Altitude: 3,000 feet.

Without Leaving the Ground ...and so can you

Climb into this new simulator that cuts instruction time to get you winging for less cash

By RONALD M. BENREY

Planning to learn to fly this year? If you are, chances are good that you will spend part of your "flying time" anchored firmly on the ground—in a pint-size flight simulator called the GAT-1 (for General Aviation Trainer).

Astronauts, military pilots, and airline flight crews have trained in full-scale simulators for many years. Now you, too, can start your flying lessons safely and economically at the same time. The low-cost GAT-1 is designed to simulate the movements and sounds, the feel of the controls, and the instrument readings that would be felt, heard, and seen by a pilot in actual flight, sitting in the cockpit of a single-engine plane.

The GAT-1 (built by the Link Group of General Precision Systems) simulates flight with such uncanny accuracy that the "pilot" soon forgets that he's anchored and only three feet up. More than one student has become airsick while putting the simulator through a series of fast maneuvers.

Come on "up." As a student, I flew a GAT-1 at the McIntyre Aviation flight school at MacArthur Airport, Ronkonkoma, N.Y. Come along with me now on a flight lesson to see how the system works. My flight instructor, Bill Brown, stands at the master control panel and talks to me over an intercom that's rigged to sound like an aircraft two-way radio.

The preflight check complete, I start the engine: Push fuel-mixture control to *full rich*; crack the throttle; flip the ignition switch to *both* (so each of the dual magnetos is working); hit the starter.

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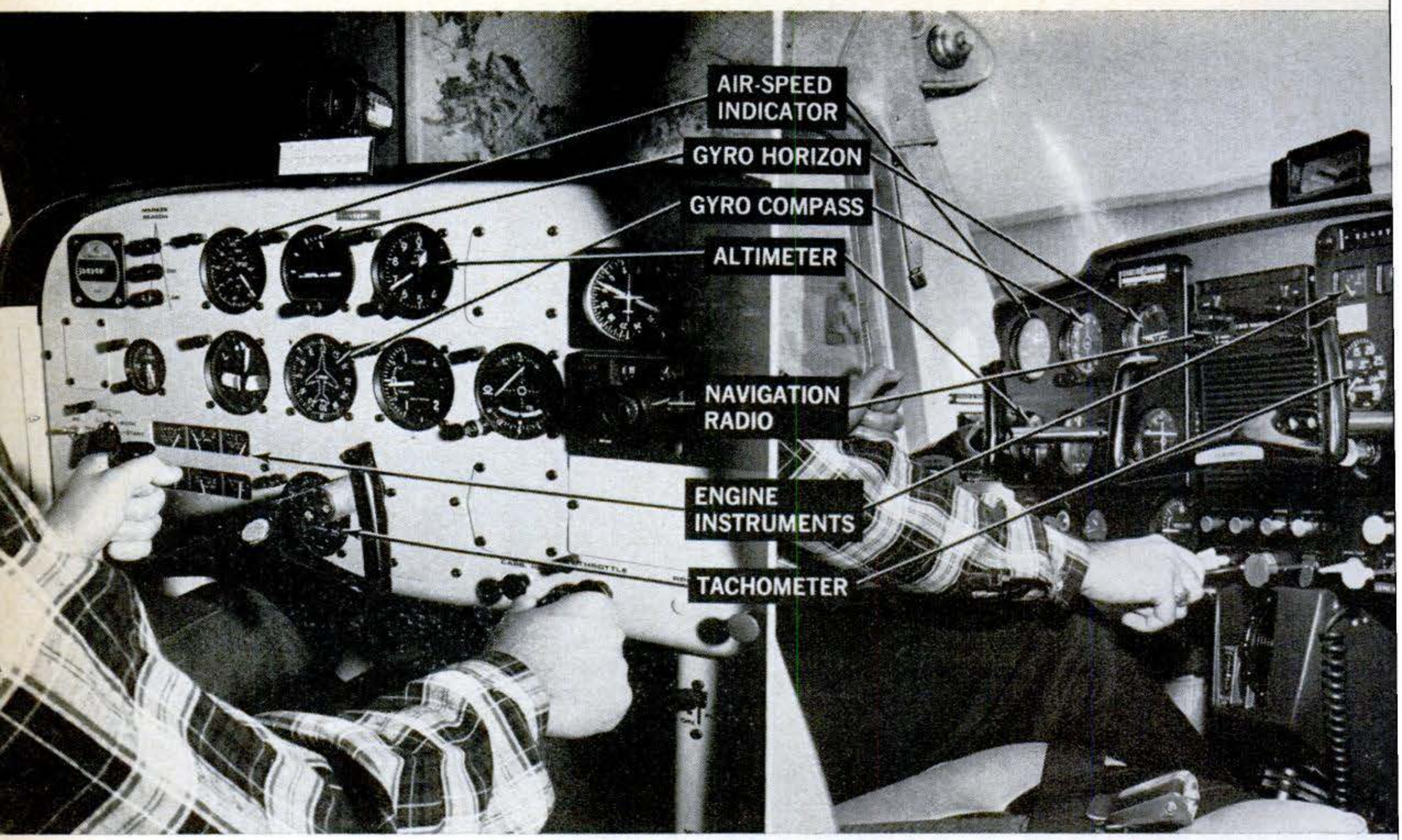


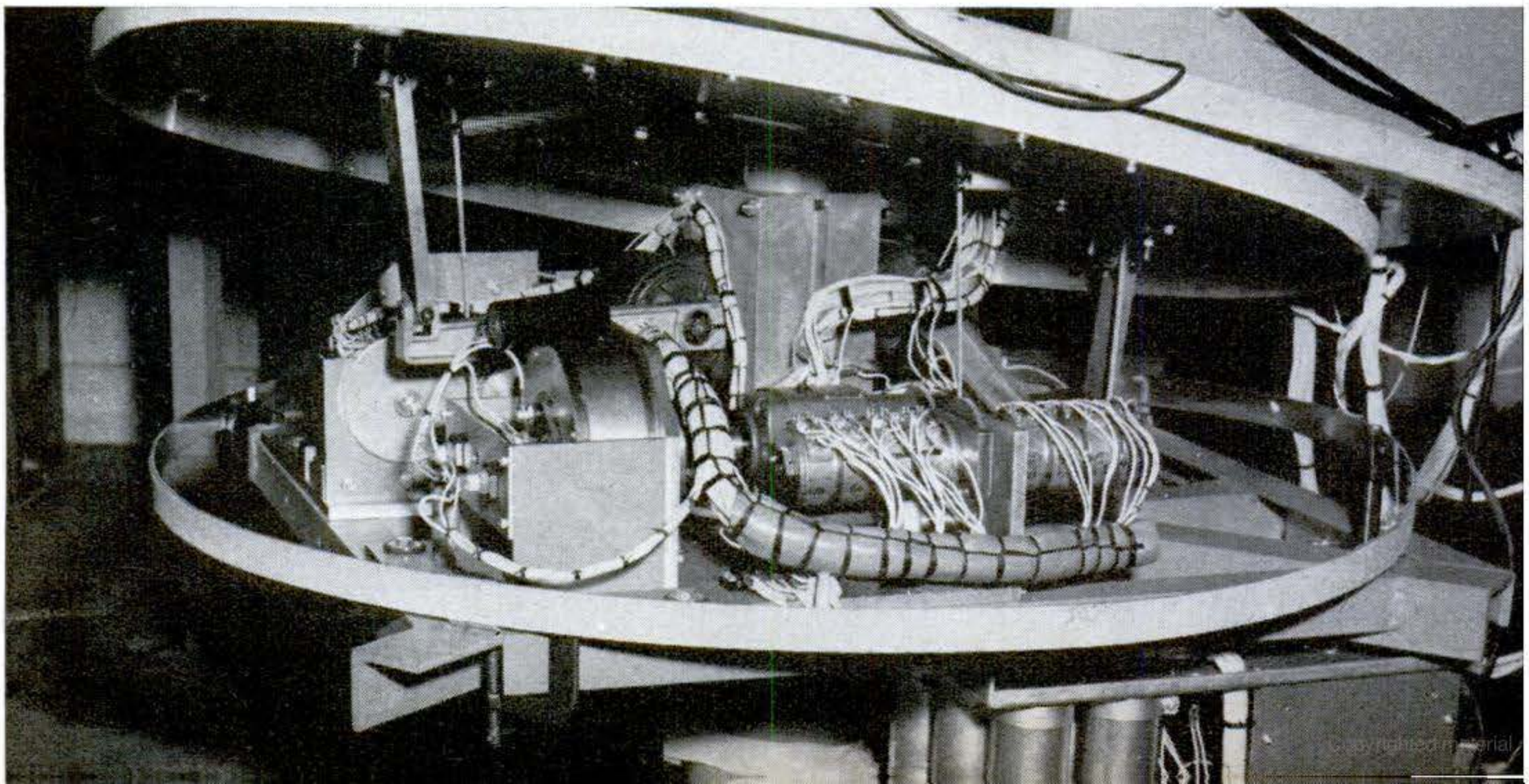
Controls and instrument panel in the simulator (left) are similar to those found in most training aircraft, such as a Cessna 150 (right). The most significant difference is that most real planes have dual control installations, to permit a live instructor to take over command of the craft if necessary.

The engine catches instantly—the tach needle climbs to about 1,000 r.p.m., and the sound of an idling engine fills the cockpit.

Next, I call the tower—actually my instructor—who gives me the runway wind velocity and direction. Clearance received, I release the handbrake and push the throttle in, for full power. The engine roars to 2,600 r.p.m., and the craft begins to roll.

At 60 m.p.h. on the airspeed gauge, I pull back the control wheel. The substantial pull necessary tells me that the

Roll, pitch, and yaw motions of the simulator are produced by a set of powerful servomotors. This new electronic approach is superior to the hydraulic and pneumatic servos used in early simulators since the electric motors are silent in operation. The other types often hiss and wheeze unrealistically.



levator surfaces on the tail are taking a big bite of the moving air.

The takeoff. There's an instant's hesitation; then the nose pitches upward, and I'm airborne. The small-engined craft climbs slowly—about 500 feet per minute. At an "altitude" of 500 feet I begin a 90-degree left turn, followed by a 45-degree right turn, in order to leave the airport's traffic pattern.

I level off at 3,000 feet, cut back engine r.p.m. to the cruise setting of 2,400 (my airspeed is about 110 m.p.h.), and begin today's lesson: stall-recovery practice.

First I turn on the carb heat control to prevent carburetor "icing." Then I throttle back to 1,000 r.p.m. I have to pull back the wheel with ever-increasing force to maintain altitude. The nose lifts higher and higher, and my airspeed plummets to below 55 m.p.h.

The dreaded stall. The blare of the warning horn sounds off behind my head: The wings are striking the "air" at such a severe angle of attack that they are losing their ability to lift the craft.

Suddenly, the GAT-1 stalls—the nose slams downward, and the altimeter unwinds like a Yo-Yo. To recover, I reapply full power, kill carb heat, and push the wheel forward, to make the craft fly out of the stall.

Several more practice stalls and recoveries, and it's time to come home. I contact the tower, reapply carb heat, and throttle back to 1,500 r.p.m. My plane begins a slow descent.

Speed: 80 m.p.h. Altitude: 1,000 feet. I enter the traffic pattern and begin my approach by flying a downwind leg (parallel to the runway, with the wind). I turn left into the base leg (perpendicular to the runway) and lower the flaps halfway. The GAT-1 noses up, and the rate of descent drops because of the extra "lift." Speed: 70 m.p.h. Altitude: 600 feet.

At 400 feet, I turn into the final approach (aimed at the runway, against the wind) and lower the flaps completely. The GAT-1 drops in for a perfect landing.

I could have made much the same flight in a real plane, except for one fact: On the day I piloted the GAT-1, two inches of rain fell in the vicinity. Nary a student was in the air.

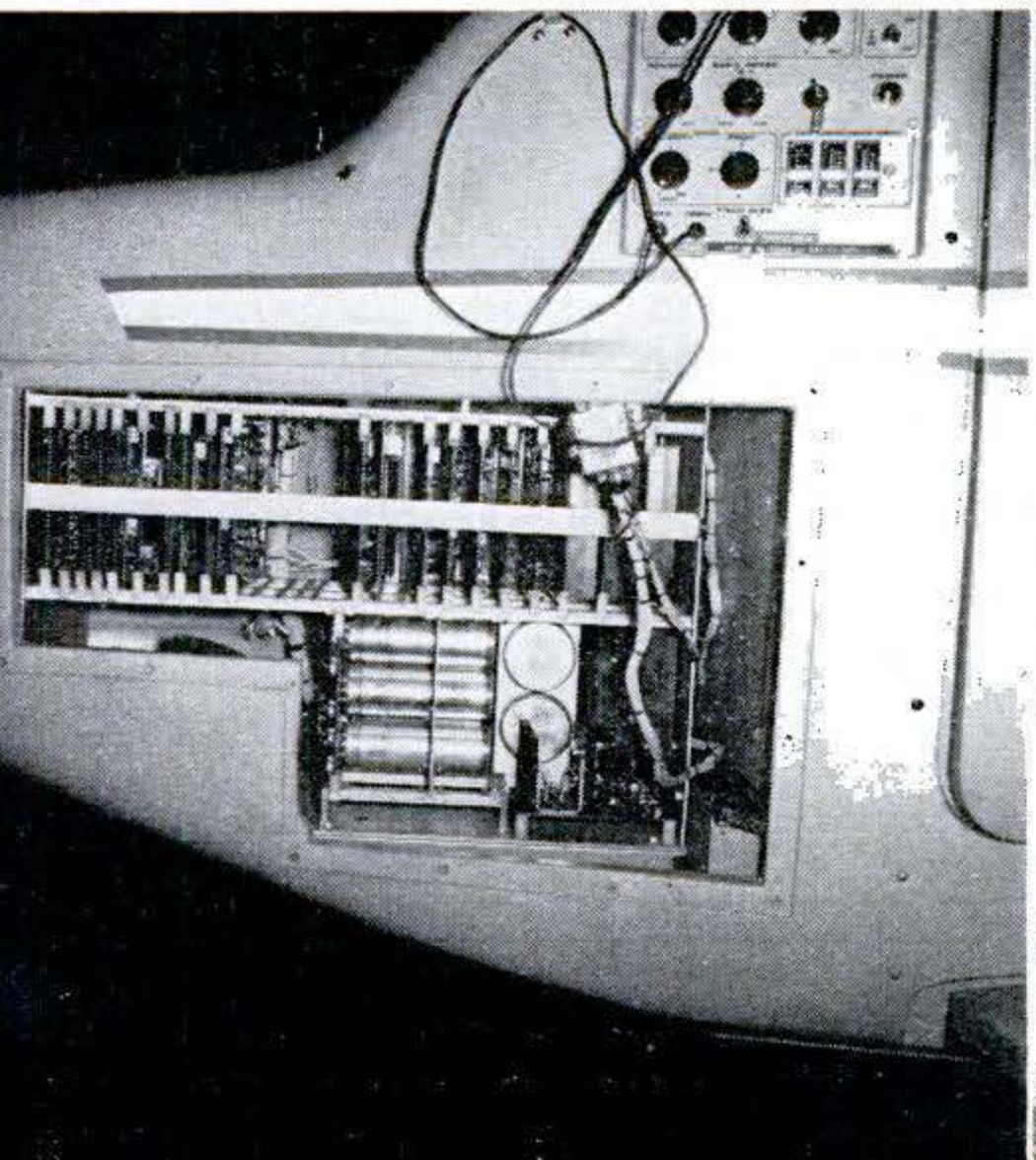
Obviously, you learn to *fly* in a plane. But simulated flight is a practical way for a fledgling to gain confidence and make a solid, no-rough-edges start.

McIntyre students spend about 10 percent of their total flying time in the simulator—most of it perfecting instrument flying. The hourly cost is about a third less than real aircraft time: $18 per hour dual (with instructor), $10 per hour solo. But considering the superior efficiency of simulator time, the savings are greater than these figures show.

Practice flying, performed in real trainer aircraft, uses expensive flying and teaching time very inefficiently.

[Continued on page 228]

GAT-1's circuitry is wired on a set of printed-circuit boards that plug into a frame chassis. All of the circuits are fully solid-state (no tubes).



Instructor's control panel on the outside lets him introduce flight problems that the student must cope with, including even "running out of fuel."

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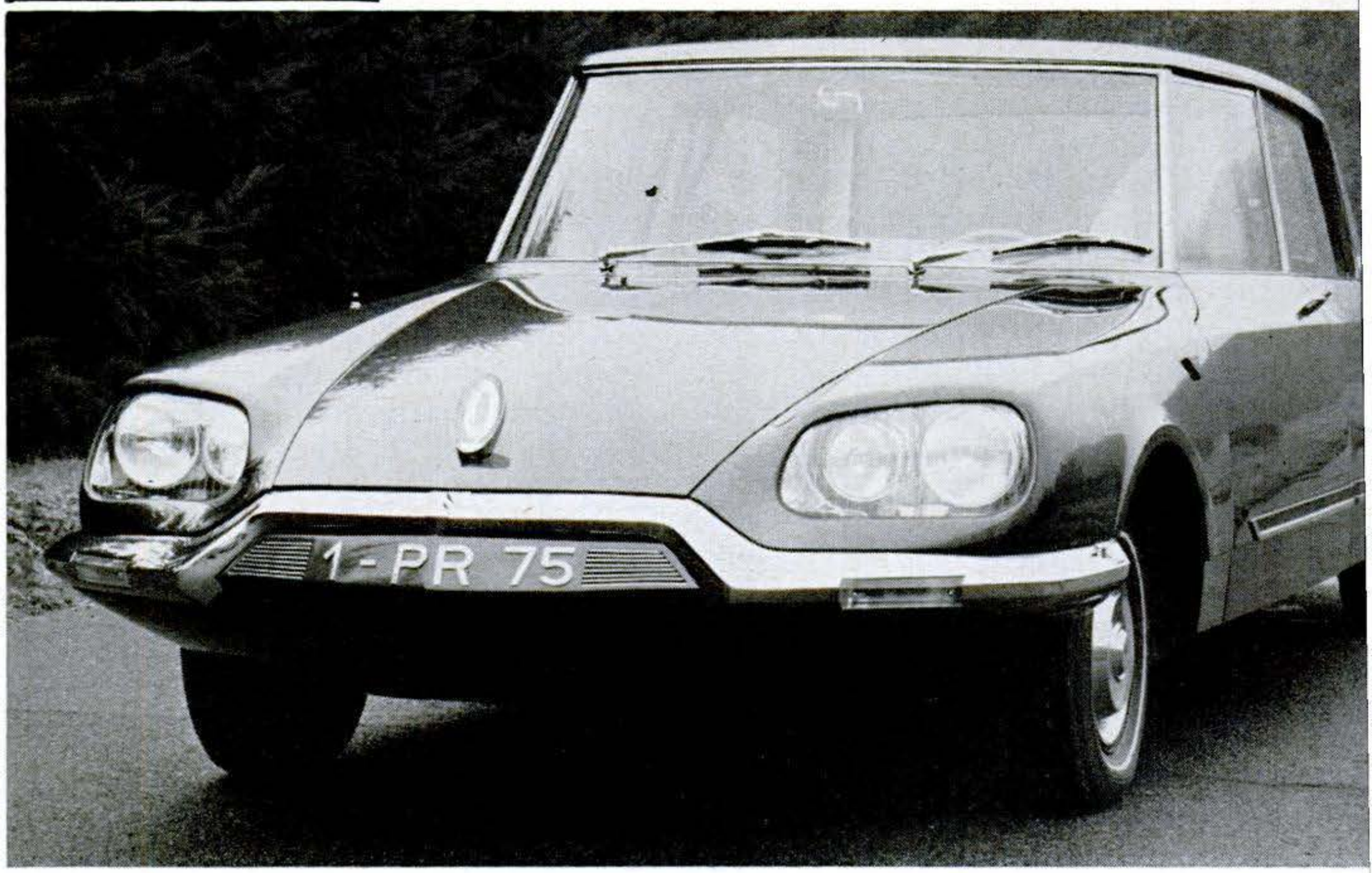

Le Grand Charles gets La Grande Citroën

The specter of deflation in France certainly didn't inhibit designe of this Citroën, which was custom-built for President de Gaulle. Th $50,000 limousine is over 21 feet long and seven feet wide, giving th long-legged general plenty of leg room. De Gaulle also has at h fingertips in either armrest (see above right) controls for air cond tioning, hi-fi radio, and electric windows. The two-ton vehicle use mechanical parts from the DS. 21 with hydropneumatic suspensio Its 109-hp. engine isn't meant for speed, but special gearing and coo ing allow the car to crawl at four m.p.h. without overheating whe President de Gaulle rides in state processions.

Fun vehicle is at home on land or water

Here's another go-an where vehicle—the Sport man. A six-wheeled bugg it rides on its wheels whe the going is easy, and c optional tracks (as at lef when it's in swampy muddy terrain. The a wheel-drive vehicle is pov ered by a 16-hp. Onan e gine and can hit 20 m.p. on land. Cat-A-Gato Hamel, Minn. 55340.

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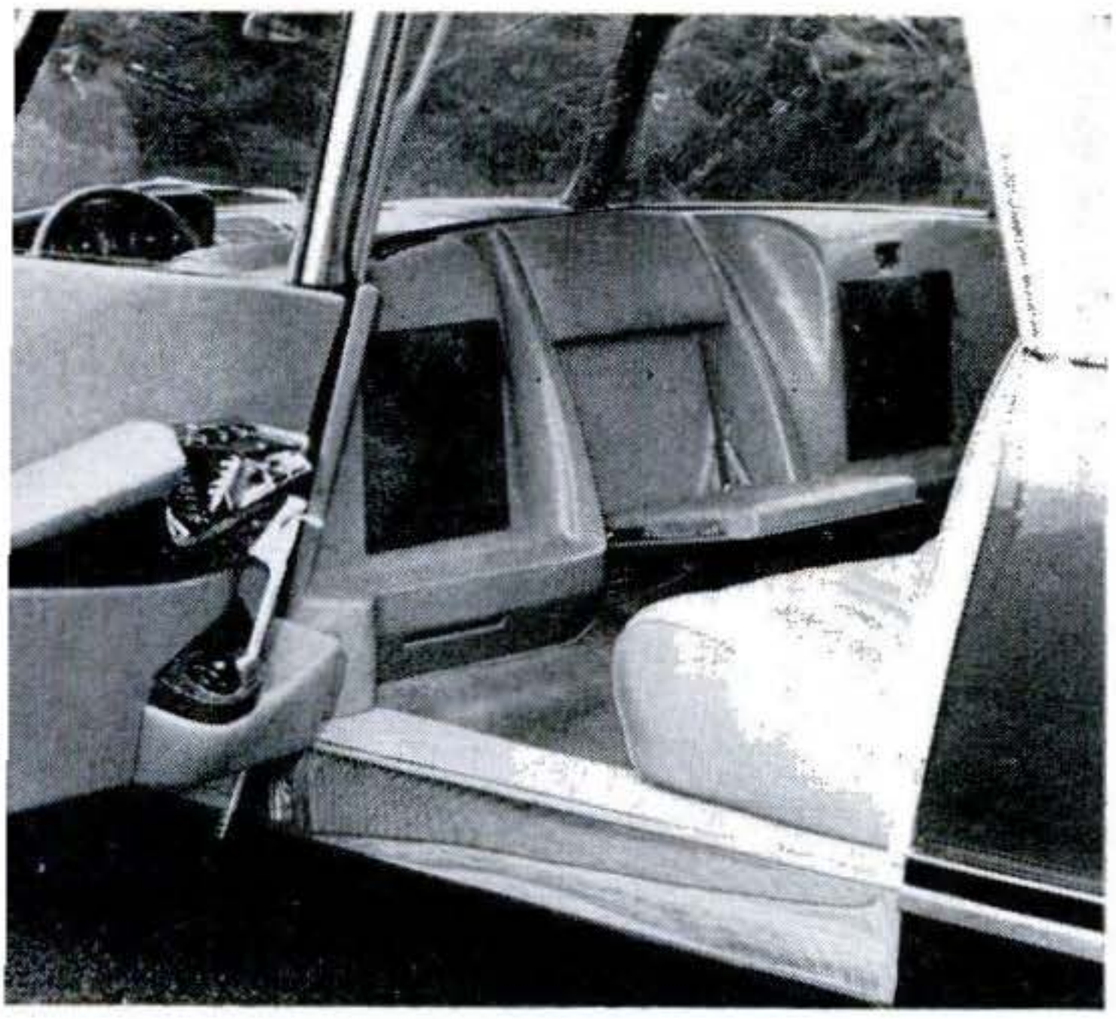
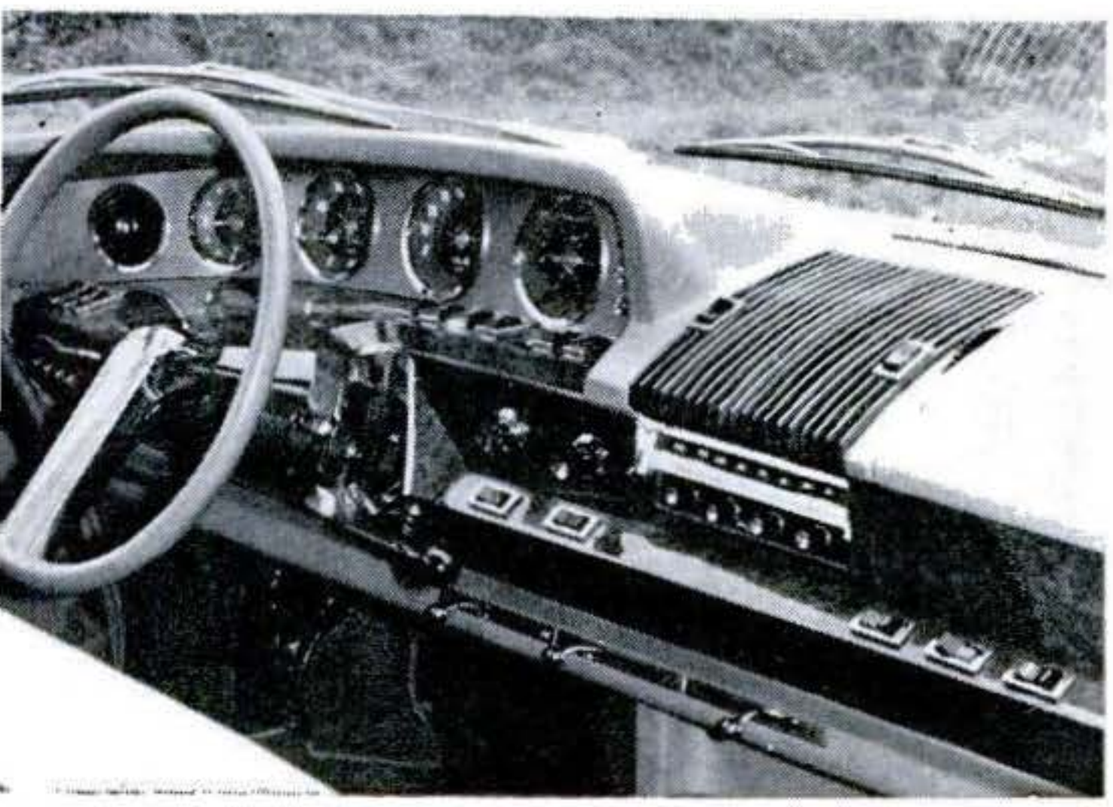


Rear compartment has jump seat for interpreter. Armrests house radio and communications controls.



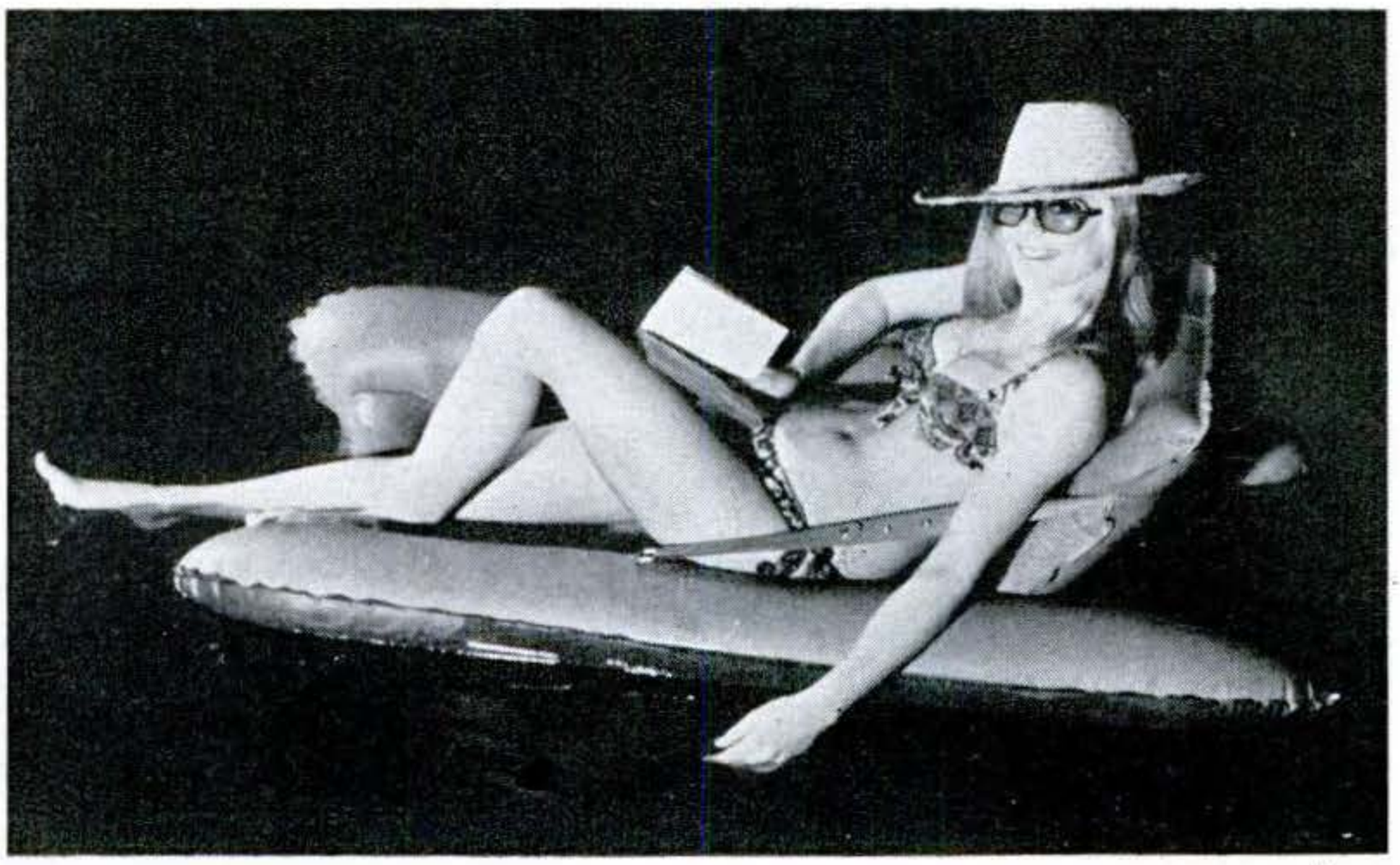
Presidential car's driver faces a dashboard loaded with special security and communications devices.

Oil derricks move on air cushion

This 170-ton oil derrick was moved into position on top of a fabric-hulled hovercraft in the Tyumen oil fields of western Siberia. Russian engineers tow such 130-foot-high towers from site to site with one crawler tractor, after the ACV is tucked around the structure's base and is airborne. The method eases moving derricks over the swampy area.

Inflatable lounge for pool relaxing

The cool-looking damsel at right enjoys all the comfort of a living-room chaise in her pool with this Lazy-Lounge made by the Kayak Corp. of America. The nylon-and-neoprene float is puncture - resistant and weighs only seven pounds. Straps adjust the backrest positions.



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What "Close Calls" Do to You and You

New "mind-reading" cars are testing how drivers react to heavy traffic, bad road conditions, and crisis situations. Purpose: to find out how good you are and how much you can take

Really loaded, this '66 Ford wagon used in University of Minnesota study contains $30,000 in electronic equipment. Electrodes fastened to driver feed data to tape recorder. Small oscilloscope checks if gear is working. Equipment requires a 130-amp alternator and fire-engine battery to power it.

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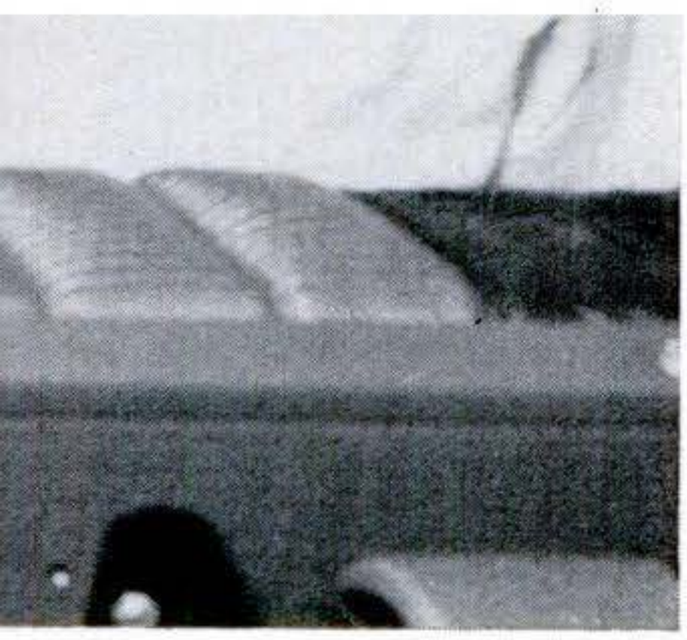
Driving

ow much can you take? Driver ress and strain under heavy affic conditions is studied rough constant check on heart te, perspiration, brain waves, ood pressure, and respiration.



By JAMES G. BUSSE and W. STEVENSON BACON

Science is "getting the goods" on what kind of driver you are. The time may be coming when, after you apply for a license, you'll be led to a shiny new car and asked to demonstrate your piloting ability. Superficially the car will look like any other, but it will be specially equipped to study you—to sense your emotions in heavy traffic, measure your heartbeat, check how heavy a foot you have on brakes and accelerator.

Want to argue about it? You'll have to argue with a computer that will neatly sum up you and your driving in comparison with a large statistical sampling.

There are good reasons for determining the effects of road stress on a driver. Right now, it's for science. But ultimately, many experts hope, universal testing will become practical. Here's what it can do:

- Poor drivers can be eliminated or retrained. And, incidentally, an instrumented car makes an excellent training vehicle for beginners as well as problem drivers —the instructor can keep an eye on the student's emotional state as well as on every aspect of his driving.
- Health risks can be spotted. In a demanding driving situation, your heart rate can increase by 20 percent—much more if you have a history of heart trouble or are in a really crucial spot. The effects of fatigue, drugs, and alcohol can be accurately charted.
- Highway design can be improved. How, for example, can the stress of merging into heavy traffic be reduced? How alert are you after long hours of nonstop driving on a boring throughway? Instrumented cars can find out.

So impressed was the Secret Service with the new techniques of testing drivers and their performance that it last year ordered an evaluation of White House agents who drive for the President and Vice President. Using Ford's HSR car (for *H*ighway *S*ystems *R*esearch), the agents were compared with each other, a group of professional driving instructors, and Washing-

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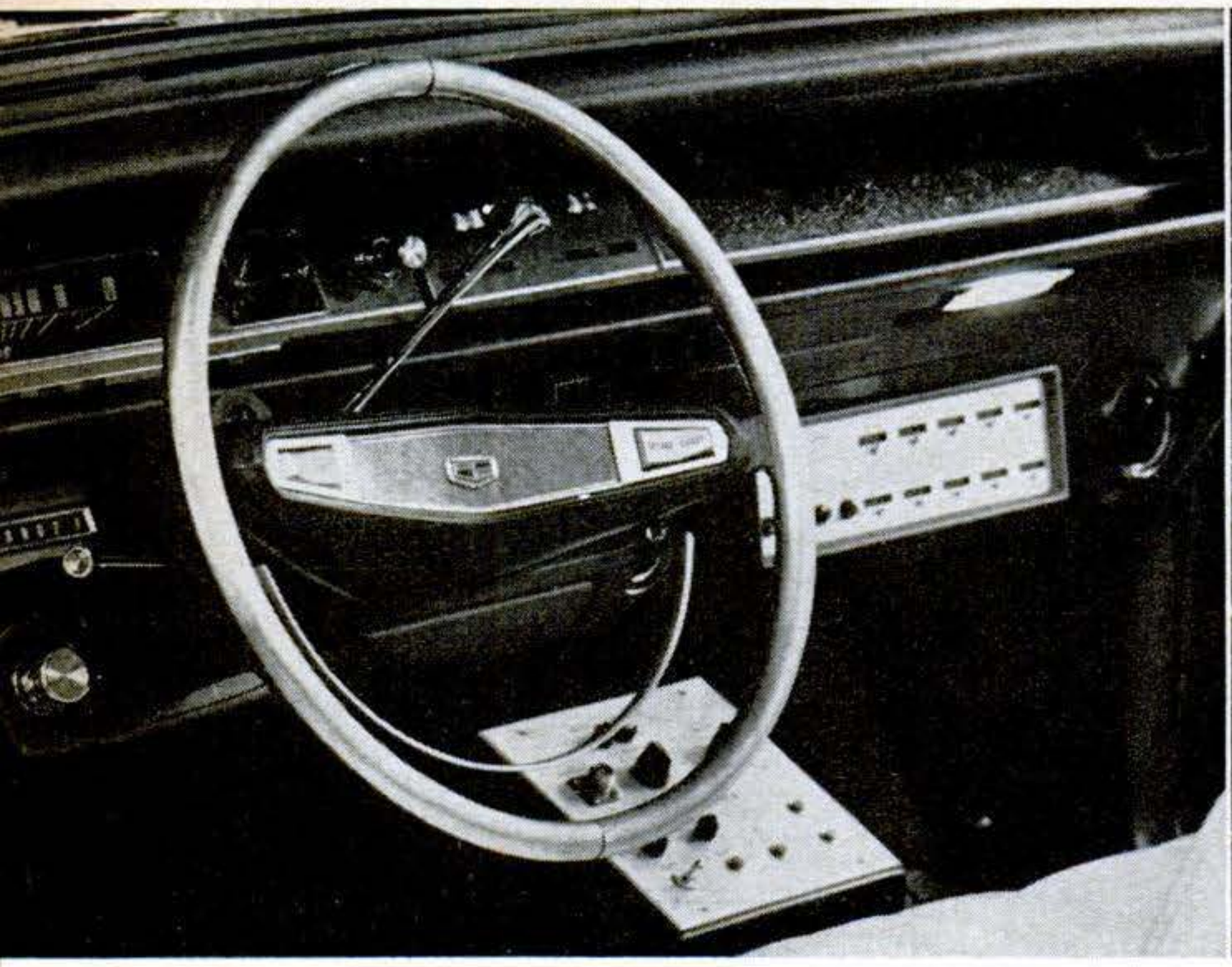
By studying stress—those things that bother all drivers—cars a



'69 model of Highway Systems Research car is this Mercury convertible, stock except for gold-plated steering wheel and two special consoles.

Trunk of HSR car holds 110-volt inverter, 20-chann multiplexer to combine data for recording and r corder. Tape can be read directly into a compute

ton police. A repeat is due this year.

What physical effects do demanding driving conditions—or close calls—have on the driver? One of the most sensitive indicators is galvanic skin response, or GSR, which is actually a measure of perspiration. Under stress you sweat, and the lowering of your skin resistance to a small electric current can be easily measured.

GSR is a good indicator of your emotions, for it shows alertness, anticipation, apprehension, or sudden startling events. Merging, passing, and turning are examples of things that affect your GSR.

Heartbeat is another sign of how driving affects you. In research with one of the most thoroughly medically instrumented cars ever produced, Dr. Ernst Simonson of the University of Minnesota recently confirmed that your heart rate responds instantaneously to such things as sudden stops, overtaking, acceleration, and dangerous curves. (The pulses of race-track drivers sometimes hit 200 or more.)

Although heart rate slows on long drives, Simonson's studies show that "significant electrocardiogram changes may occur during driving and often to a degree which would be an abnormal response in other stress situations . . ." I other words: Driving places a definit stress on the driver's heart—one that h may or may not be able to tolerate.

Simonson and his associates spent tw years testing the stress and strain o drivers in every age group, both norma individuals and a number with healt problems. A laboratory on wheels, thei instrumented station wagon continuousl monitored drivers' electrocardiogram GSR, brain-wave activity, blood pressur and respiration. Other sensors measure steering, acceleration, and braking.

More cars that "read your mind." Ford' HSR car mentioned earlier shows sign of becoming a standard test vehicle fo research and for rating your driving. De veloped by Fletcher N. Platt, manager o Ford's Traffic Safety and Highway Im provement Department, the HSR car is 1969 Mercury Marquis convertible tha features a gold-plated steering wheel.

Not only does the steering wheel ad a sporty touch, but it becomes a robo doctor, monitoring the driver's pulse o GSR. Gold happens to be the best con ductor for the purpose. A number o HSR cars will be built for state agencie university researchers, insurance com panies, and other clients.

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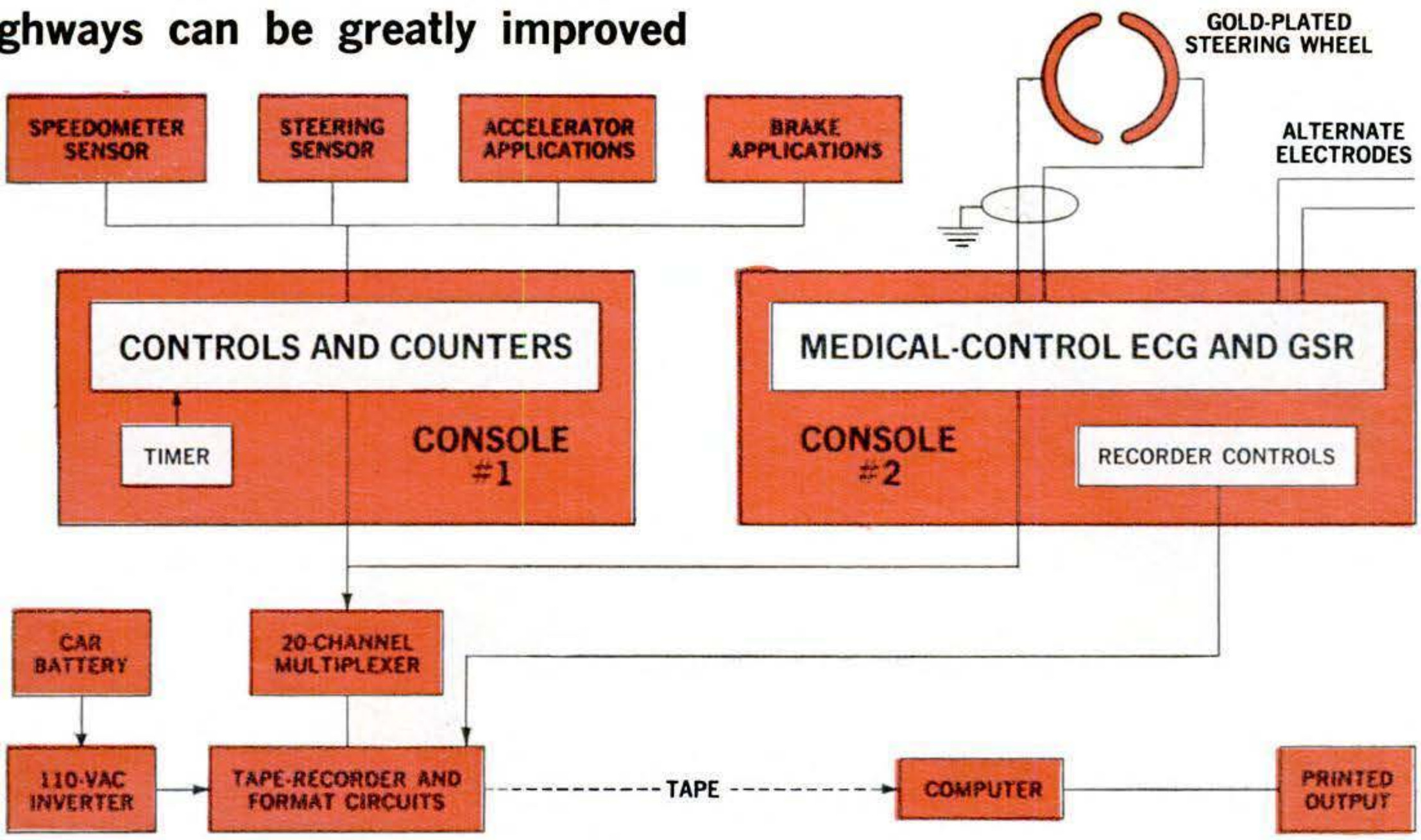
ghways can be greatly improved



HSR car can simultaneously record both GSR and ECG by using alternate electrodes taped to driver. Console No. 1 (counters) is under dash at right; medical and recorder controls are over tunnel. Steering changes are actually broken down into fine and gross reversals. Running, total times are recorded.

Instrumented by Chesapeake Systems Corp., the HSR car keeps close tabs on your driving. Every move is noted and recorded, including fine steering reversals (tracking motions or turns of the wheel more than two degrees), gross steering reversals (turns and lane changes; more than 12 degrees), acceleration reversals (up and down movements 1/8 inch or greater), and brake reversals (depressing brake 1/8 inch or more).

Collecting the data. Under the dash opposite the driver is an array of counters that click merrily as you drive, displaying 10 different kinds of information. An instructor or researcher has merely to glance at the panel to determine how you're doing—both physically and as far as your driving is concerned.

Another control console sits over the drive-shaft tunnel. Besides selecting the type of medical data desired, it triggers a large, multichannel tape recorder in the Mercury's trunk. Along with the necessary electronics and power supply, it records as many as 20 channels of data for up to four hours at a rate of 22½ bits of data per second on each channel.

The tape recorder automatically prepares data on you and your driving in a form that can be handled by a computer. This gives an instant analysis of how you rate—whether or not you're a competent driver.

Better drivers, cars, roads. Research on drivers and driving is in its infancy, but interesting new projects are mushrooming. Examples:

- At Texas A&M, engineers are studying freeway merging. They want to know what ramp design is best.
- Researchers at Penn State recently tested how well drivers perform when fatigue is simulated by hypnosis.
- A recent project at Iowa State tends to show that you need a warm-up period of driving—perhaps as much as 30 minutes—before you're at your best.

"What's needed," says Ford's Fletcher Platt, "is a common language that will tie together traffic, highway, and automotive engineers, and medical and driving-education experts. Then we could talk about traffic in terms of stress factors instead of flow or volume, and mention heart-rate changes instead of highway grades and elevations. The HSR car could help provide this language."

The end objective is not only to find out how close calls affect you and your driving, but to eliminate the possibility of those close calls. PS

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Typical failure in poor-quality boats is a crack in the hull (above) due to material fatigue. Area with crack was cut out for inspection. Flaw appeared whe fabric layers had delaminated, or separated, becaus

What Can Go Wron

Tests by pros demonstrate how quickly cracks and flaws can show up in a poorly made hull

By WALLACE CLOUD

Fiberglass-reinforced plastic is probably the best material ever developed for boat-building. It's used now for all sizes of craft—from family runabouts to Coast Guard patrol boats. Plenty of satisfied owners know that a well-made glass boat, if treated and maintained properly, will last a good many seasons.

Some boaters, however, would rathe sit on the beach than own a glass boa Unfortunately, enough can go wrong wit a poorly built fiberglass hull to justif that feeling. Like any product, quality c construction makes all the difference i whether your boat will last for years c fall apart in a few months.

One way to find out what makes a goo fiberglass boat good is to see what make a bad one bad. To do this, I visited Trop ical Marine Testers, Inc., an independen laboratory in Palm Beach, Fla. There saw a fleet of fiberglass runabouts tha had been tested to destruction. The weren't typical of fiberglass boats, bu were perfect examples of the worst kind of flaws you could ever find.

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resin bonding them had fatigued. The white areas at right show partial or complete delamination. All fiberglass will eventually fatigue but some of the boats under test failed in as little as eight hours.

with Fiberglass Hulls?

Bob Flagg, TMT's president, explained that these boats—20 of them—were being tested to provide evidence of poor construction in a lawsuit against the maker. A dealer had brought the suit as a result of customer complaints, and TMT was hired to test the boats by running them through waves and cruiser wakes until the hulls failed. They failed miserably, some in as little as eight hours.

Mainly, the flaws resulted from improper reinforcement of fiberglass sections with wood, and poor application of resin to the fiberglass.

Nearly all the boats had two holes in the glass shell of the transom. The maker had skimped on the thickness of plywood used there, and the outboard-motor

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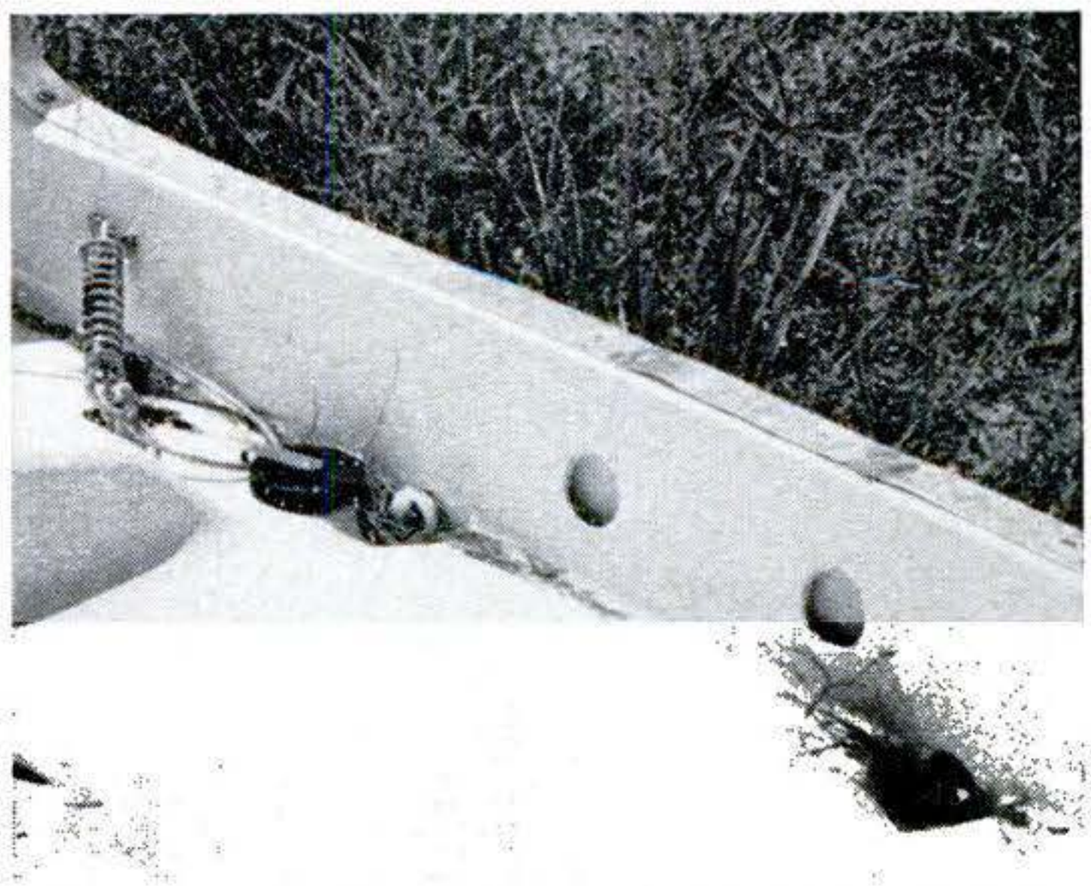

Transoms of almost all boats tested had holes punched by outboard-motor clamps. This shows that plywood used to reinforce transom was too thin.

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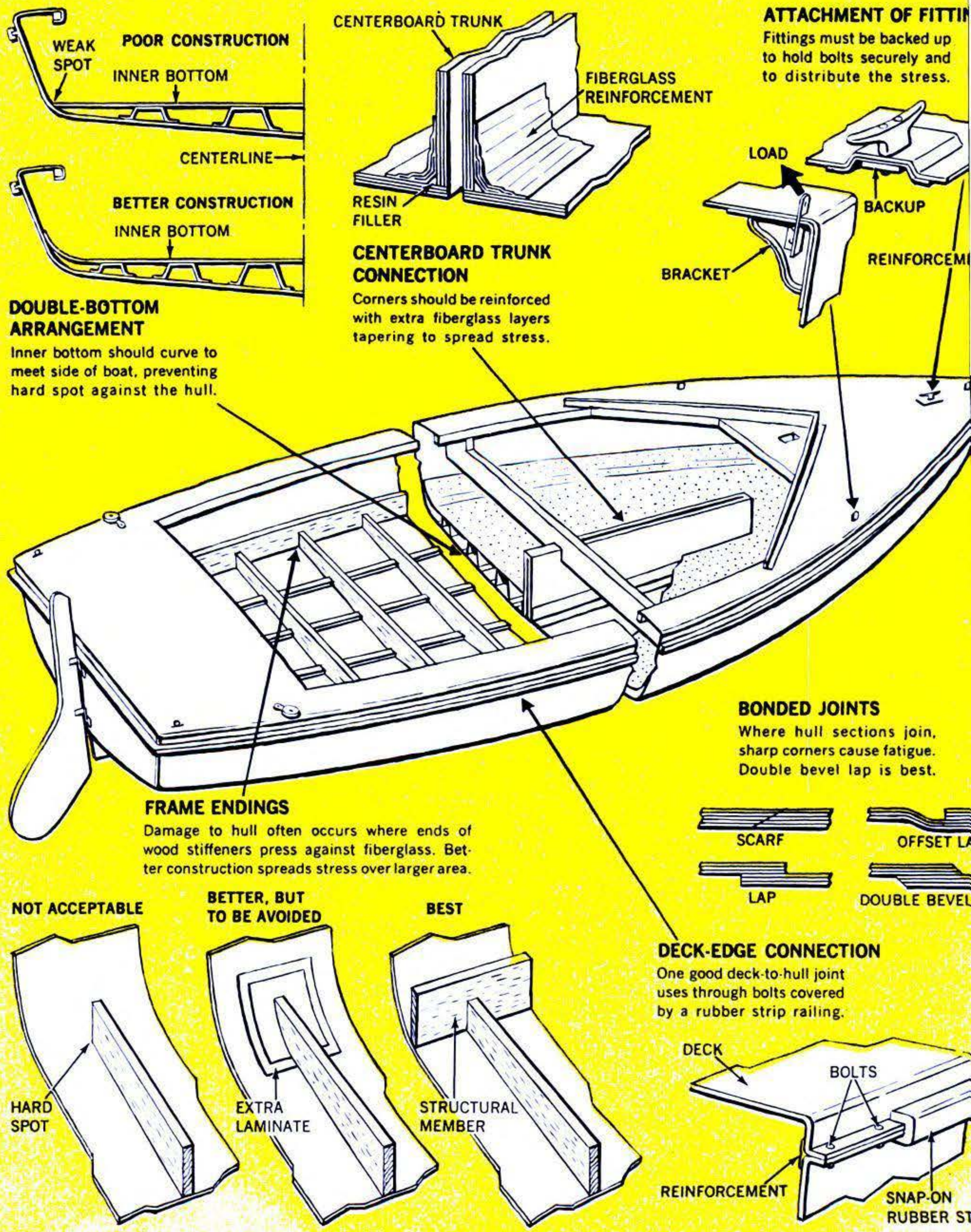
clamps had punched through. Also, wood strips, meant to be longitudinal stiffeners, were held in place with only a single layer of fiberglass cloth. The strips quickly pulled loose, letting the hull flex. All plywood was a rough and knotted exterior grade, not smooth marine grade.

Many problems resulted from ba placement of reinforcing members. En and corners of wooden pieces butted c rectly against the boats' skins, creatir hard spots where flexing of the hulls i creased the chance of material fatigu Tough as fiberglass is, the resin will fa

What to look for in fiberglass runabouts and sailbo



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like metal, at a spot where continued flexing occurs.

In all cases the hulls had split or cracked during testing. After each failure the TMT men cut out the damaged section for inspection. The major faults they found were:

- Not enough resin—in some cases none at all—impregnating the glass cloth or mat. This caused structural weakness and allowed layers of cloth to separate. (In one boat, water had formed a blister between delaminated layers near the driver's feet. It burst, spraying a jet of water in his face.)
- Too much resin absorbed by the fiberglass. This caused hard lumps or strips against which adjacent areas flexed, leading to fatigue. In some cases resin drops had hardened like icicles on wooden braces, and, after rubbing against the hull, had cut through.

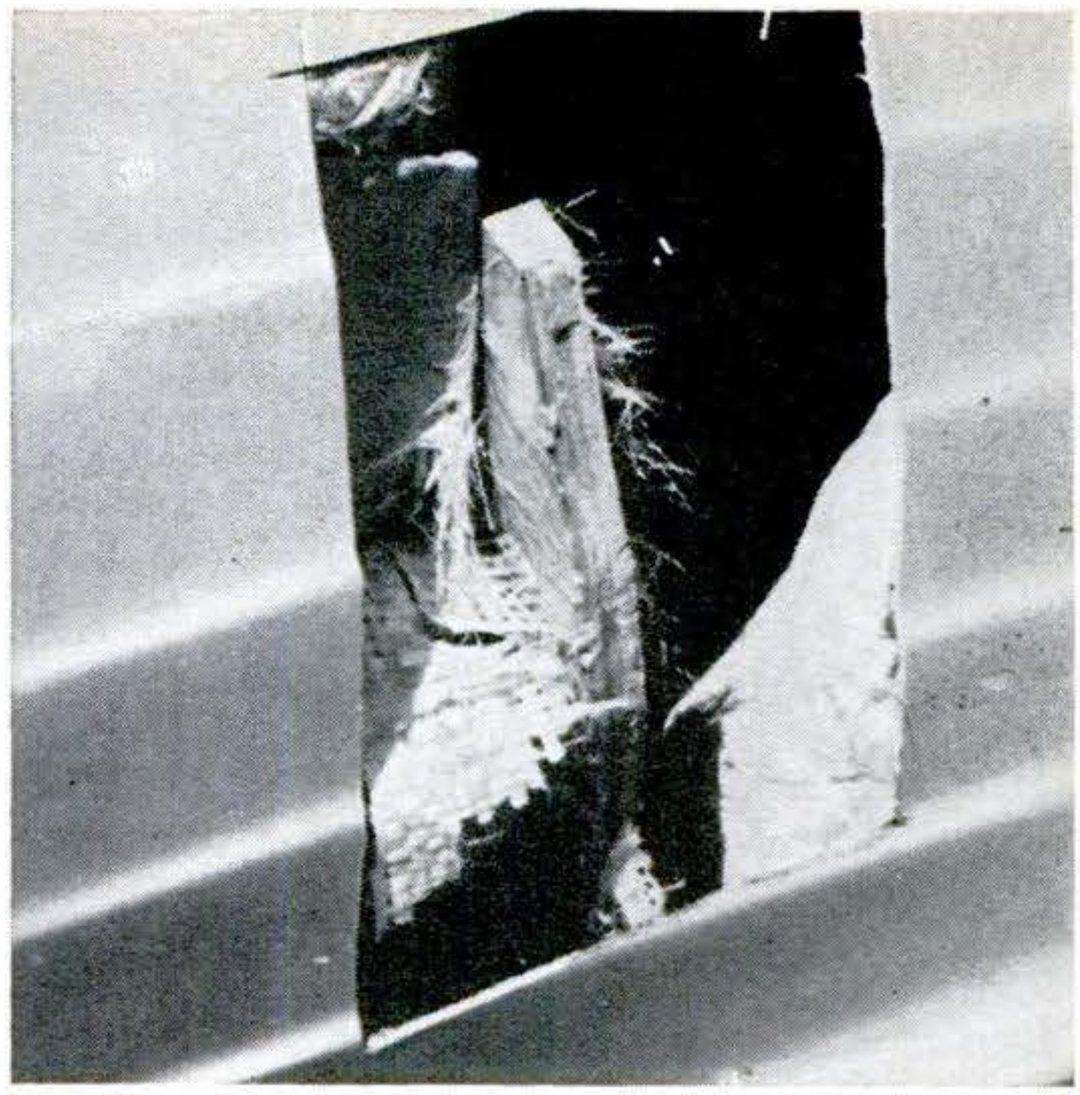
Removing damaged sections also showed some flaws not directly related to fiberglass. In one boat, the foam flotation occupied only a small portion of the bow cavity it was supposed to fill. This probably happened because the boat was built in cold weather. Foam, poured in as a liquid, needs warmth to expand properly.

What does this mean to you? Flagg said that the boats on the market cover "the whole spectrum—from boats like these to boats that will last virtually forever." He estimates that a good boat, if you don't abuse it, as with too large a motor, should last at least 500-600 operating hours, some boats have lasted much longer than that.

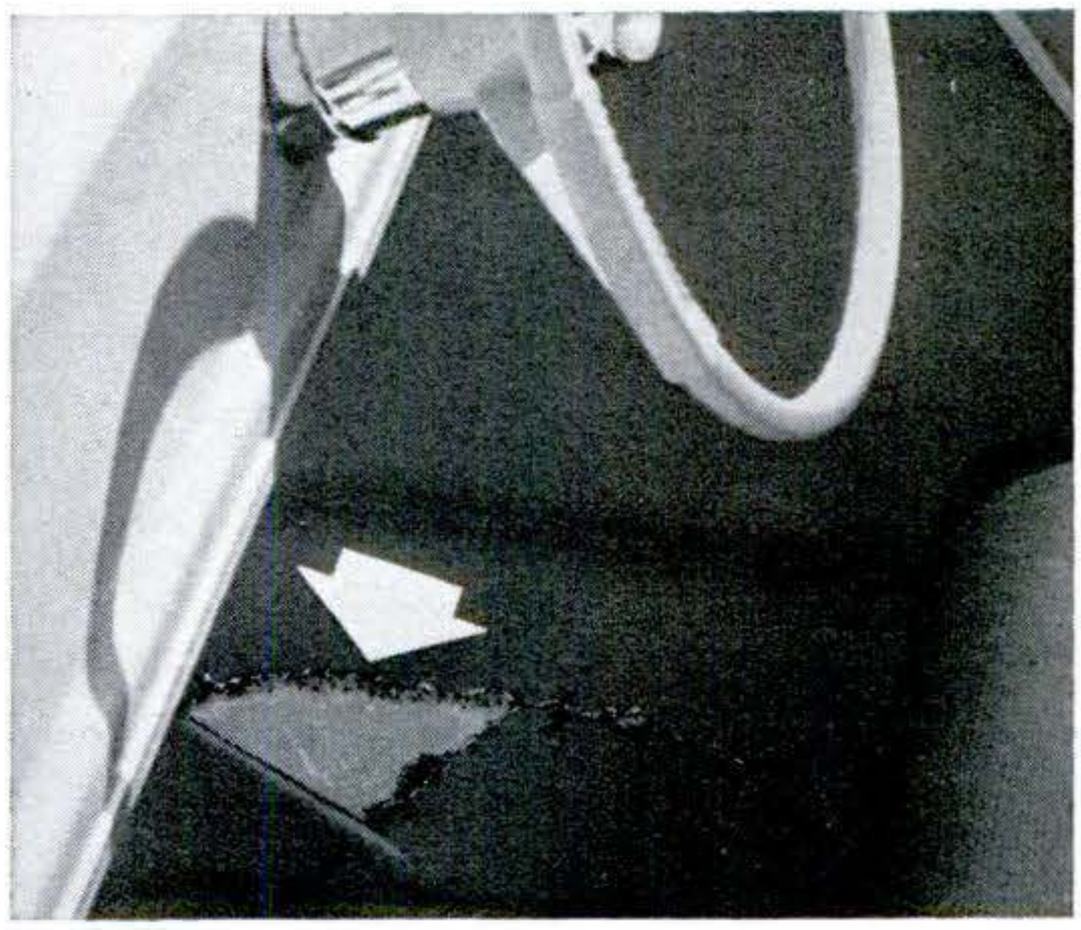
Spotting trouble in advance. How can you be sure you're buying a good new or used glass boat? Experts agree that spotting flaws is difficult. They rely heavily on the maker's reputation; and some builders are more willing than others to give you construction details in their brochures. The various building techniques—foam core versus wood reinforcement, hand lay-up versus machine spraying of chopped fiberglass, and so on—are equally valid, if handled properly.

The dealer's reputation also counts. TMT men warn that you should be extra cautious of dealers offering a nonbrand-name boat as part of a package deal with an expensive outboard.

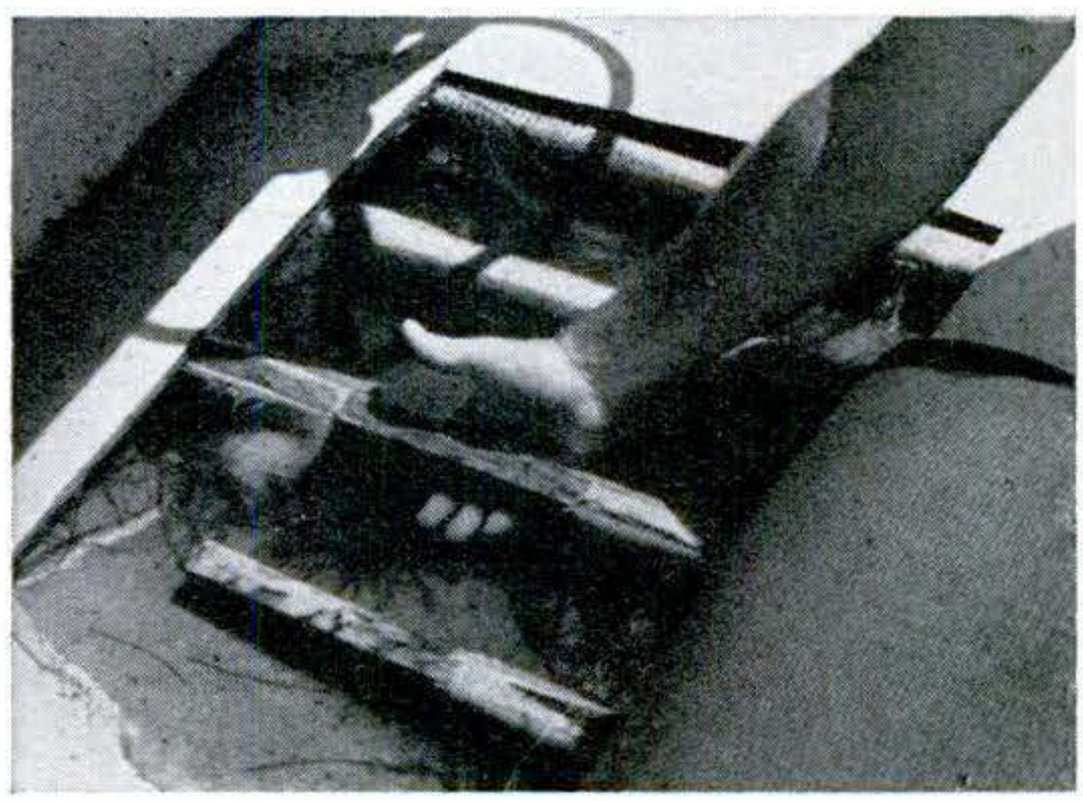
[Continued on page 229]



Hard spot, caused by unsupported frame member resting against hull, caused glass to flex and fail. White lump is flotation that failed to fill bow cavity.



Blister developed when water was forced into delaminated layers of fiberglass by pressure of planing. The blister (arrow) grew and eventually burst.



Longitudinal stiffeners were fastened to hull with a single layer of fiberglass. Insufficient fabric and resin made setup weak—strips soon pulled free.

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It's Floatable, Unflippable ...Even When Flooded

Larson's 18-foot All American for '69 has a new flotation system that makes it safer, quieter

By JIM ROE / *PS Boating Editor*

The difference in noise level was the biggest surprise of all.

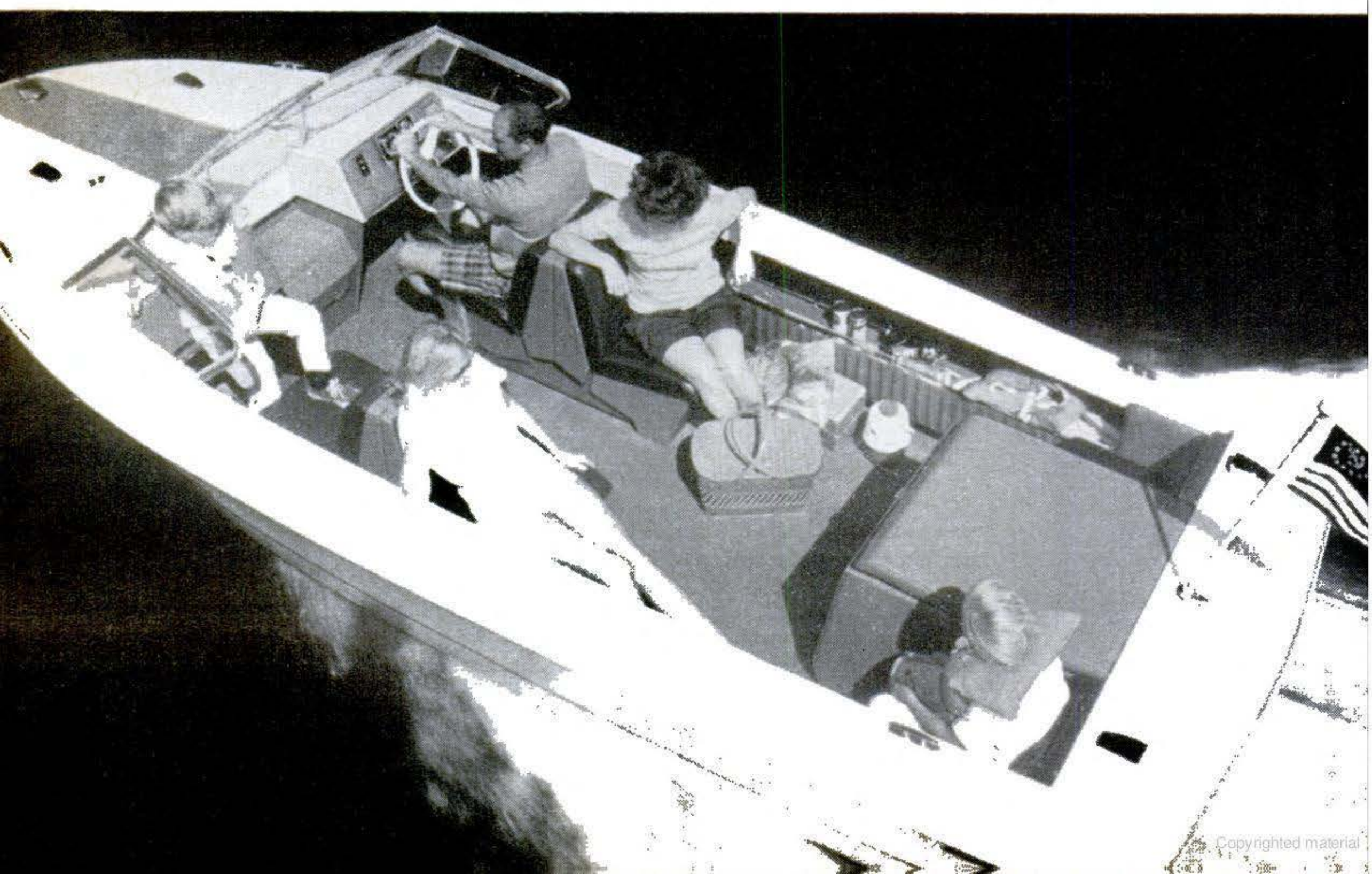
I had taken a fast run away from the dock in a 1968 model. And it was a great ride. My companion and I shouted back and forth our comments on a responsive boat, water with just enough ripple to be interesting, and a beautiful day in central Minnesota.

Then we eased the '68 back to the dock, tied it up, and headed across the river full bore in the new '69 model. Same responsive boat. Same fine water. Same great weather. But in this hull we could talk in normal conversational tones. Gone was the loud thump of chop against fiberglass. Gone was the motor resonance that had drummed through the hull of the '68 model.

We were making these test runs at Little Falls, Minn., right behind the Larson Boat works. I had come up to see for myself how Larson builds boats for 1969. The big news is Life/Guard construction.

Continued

Roomy enough for family and friends, Larson's 186 All American for 1969 has lots to offer in addition to the exclusive Life/Guard construction for safety and silence. Features include marine lights, built-in gas tank, mechanical steering, convertible-top set. Up front there's a skiff-style safety-glass windshield. Power options are available from 155 to 210 hp. There is also an outboard model of the boat.



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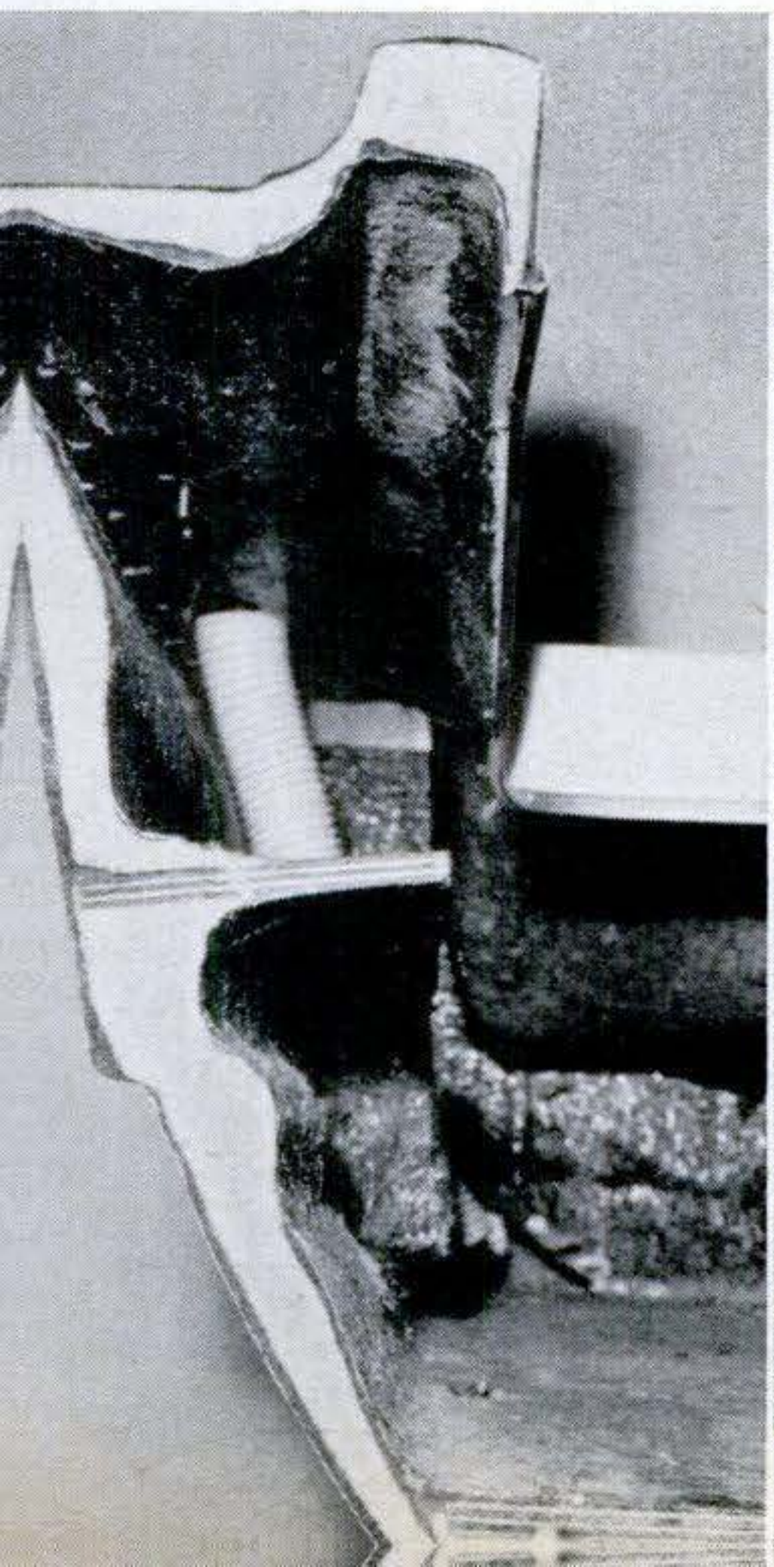
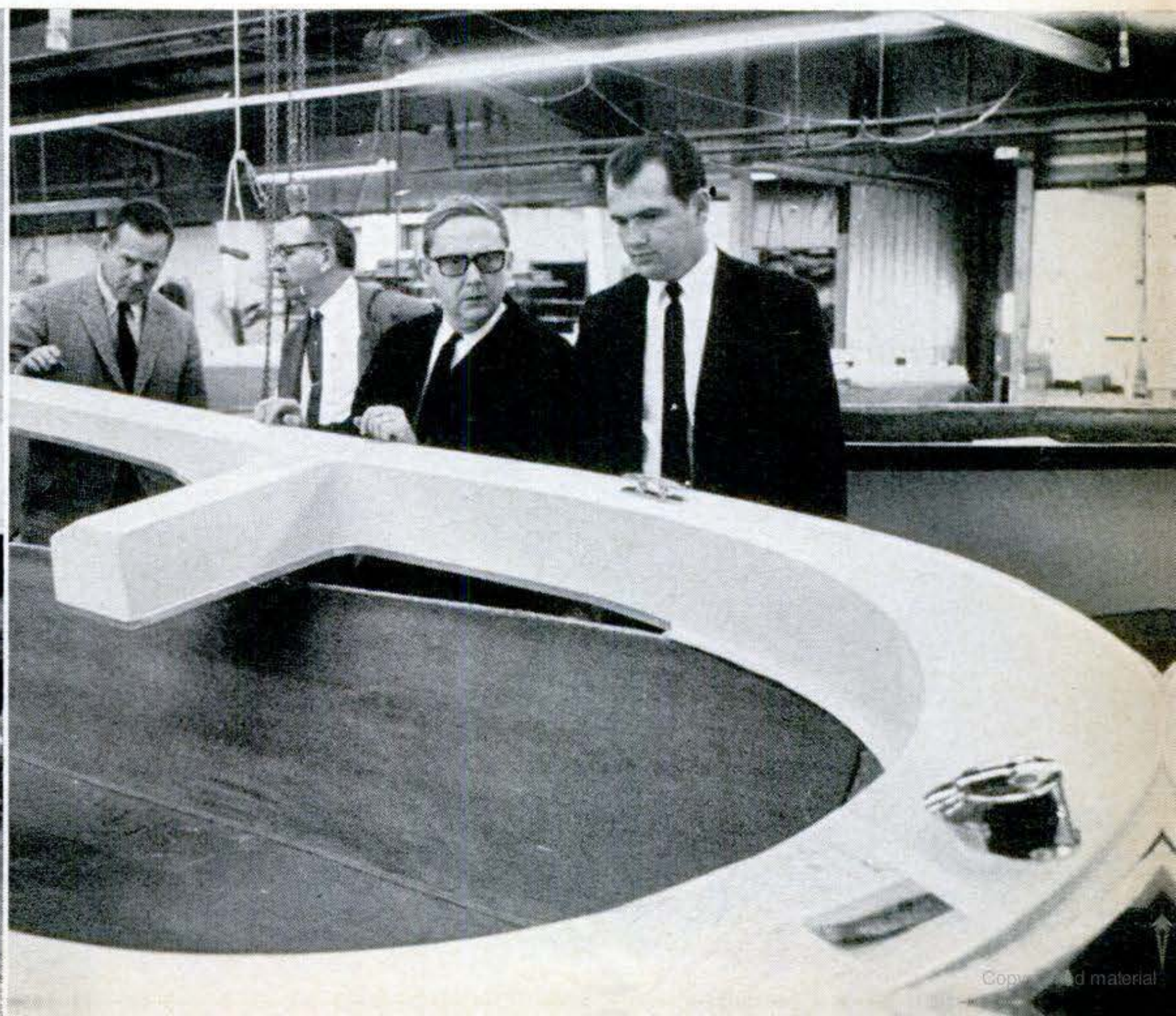
Under way, our test boat proved a competent, quiet, exceedingly responsive craft. Photo below at left is a cutaway section of Life/Guard construction: three layers of hull sandwich consisting of outside fiberglass, expanded polyurethane foam, and an inside layer of fiberglass. Photo at right shows a finished deck unit being lowered onto a completed 18-foot hull. This is the Larson 186 All American.





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Since all its features are out of sight, one needs either to saw a boat in half or go through the plant while boats are being built, in order to see just what this kind of boatbuilding is all about.

Life/Guard construction is, simply stated, a means of keeping your boat both afloat and right side up even if it should meet with an accident and completely fill with water. Flotation of some sort has been added to most fiberglass boats for many years. But in many of these, the flotation was installed below the floorboards. Thus, when a boat filled with water, the flotation that was designed to keep it afloat and help you, caused it to turn bottoms up. When this happens, you are completely out of luck as far as handholds are concerned.

The safety sandwich. Larson's new system attacks this problem in two ways: First, flotation is installed high enough in the hull to help keep the boat on an even keel; and second, the lowest part of the bilge is deliberately left clear so it is the first area to be flooded. This automatically ballasts the boat with weight at its lowest point.

The result, say Larson engineers, is a hull that is not only virtually unsinkable, but is also just about unflippable even when filled with water.

That three-layer sandwich of fiberglass and polyurethane foam, which is Life/Guard Construction, also enables the hull to take collisions that would rip a hole in a thinner-skinned hull.

Visibility from the driver's seat is excellent. A walk-through windshield allows easy access to the foredeck. It's a great boat, says the author, for fishing or skiing, or as a family runabout. It comes in either outboard or stern-drive versions. Test boat (above) has 210-hp. OMC stern-drive unit.

Back in the plant, I had seen the flotation system come into being. First, the fiberglass hull is formed and the stringers and floorboards installed. Then a special expansion-type polyurethane mixture is sprayed into the areas under the floorboards and outboard from the stringers. This foam rapidly expands to fill the entire area, bonding itself to the hull, stringers, and floorboards. This expanding foam also goes into the transom area to help support the weight of the engine. The entire bilge area—lowest portion inside the hull—is left completely empty.

Next, polyurethane foam is carefully applied to the inside surfaces of the hull and to the underside of the preformed fiberglass deck. It expands to a carefully predetermined thickness.

Final step is the application of an inner layer of fiberglass, creating a sandwich that has the fiberglass hull itself as the outside layer, the polyurethane foam as a center layer, and another layer of fiberglass inside the hull as the inner layer. All three layers are chemically bonded to each other so that the entire unit is one solid hull structure. The combination provides permanent buoyancy, a bridge-like bracing for the hull, and a tough wall against hull punctures. And you'll find this construction on every 1969 Larson—both deep-V hulls and tri-hull designs.

The silence is actually a bonus, a reminder of all of these built-in layers tucked away behind the cockpit liners and under the decking. One other reminder is the extra stiffness in the foredeck. It doesn't sag when your big feet come down on it.

Our test boat. This was Larson's new 18-foot All American 186—and quite a boat. Available as either an outboard or a stern-drive model, it has an unusually roomy one-area cockpit. Besides this, it has a walk-through windshield that makes the foredeck easily accessible. Our test boat was powered with a 210-hp. OMC stern-drive unit. This added up to a competent and responsive combination of seagoing machinery. I would have liked to have taken the whole thing right along home with me. PS

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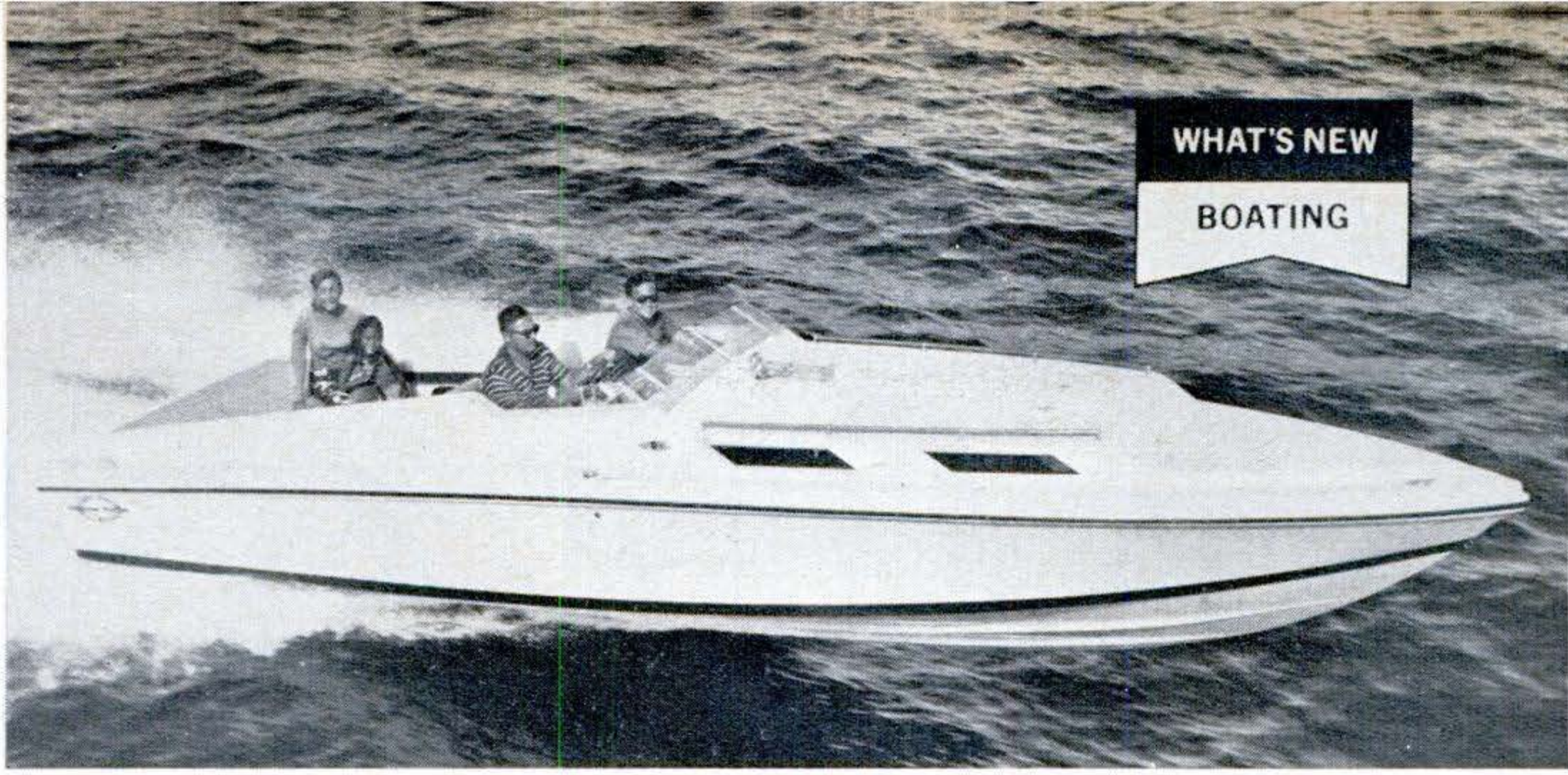
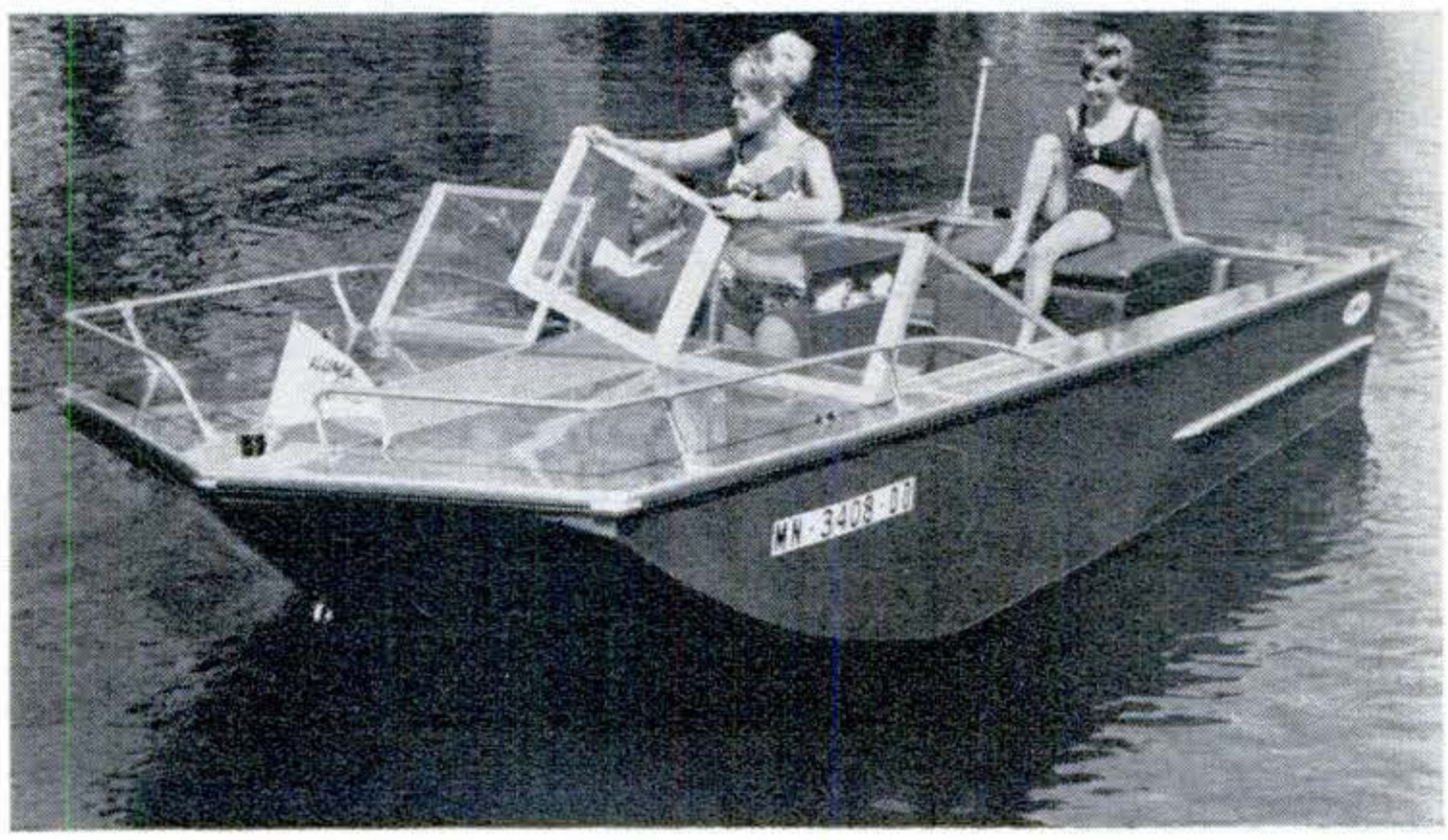


Buy a tiger for the family—a purring, water-loving 27-footer

Here's a so-called "stock fiberglass hull"—a deep-V hull—that just happens to be the same long, lean shape that has won a shelf full of ocean-racing trophies in two years of offshore competition. It's the 27-foot Magnum, shown here with windshields, a cabin, and other civilized touches. Power is supplied by paired 200-hp. Mercruiser stern-drive engines. Racing Magnums, propelled by either single or twin 475-hp. Mercruisers, have piled up an impressive number of victories, including the '67 and '68 U.S. and world championships. It's made by Magnum Marine Corp., Miami, Fla.

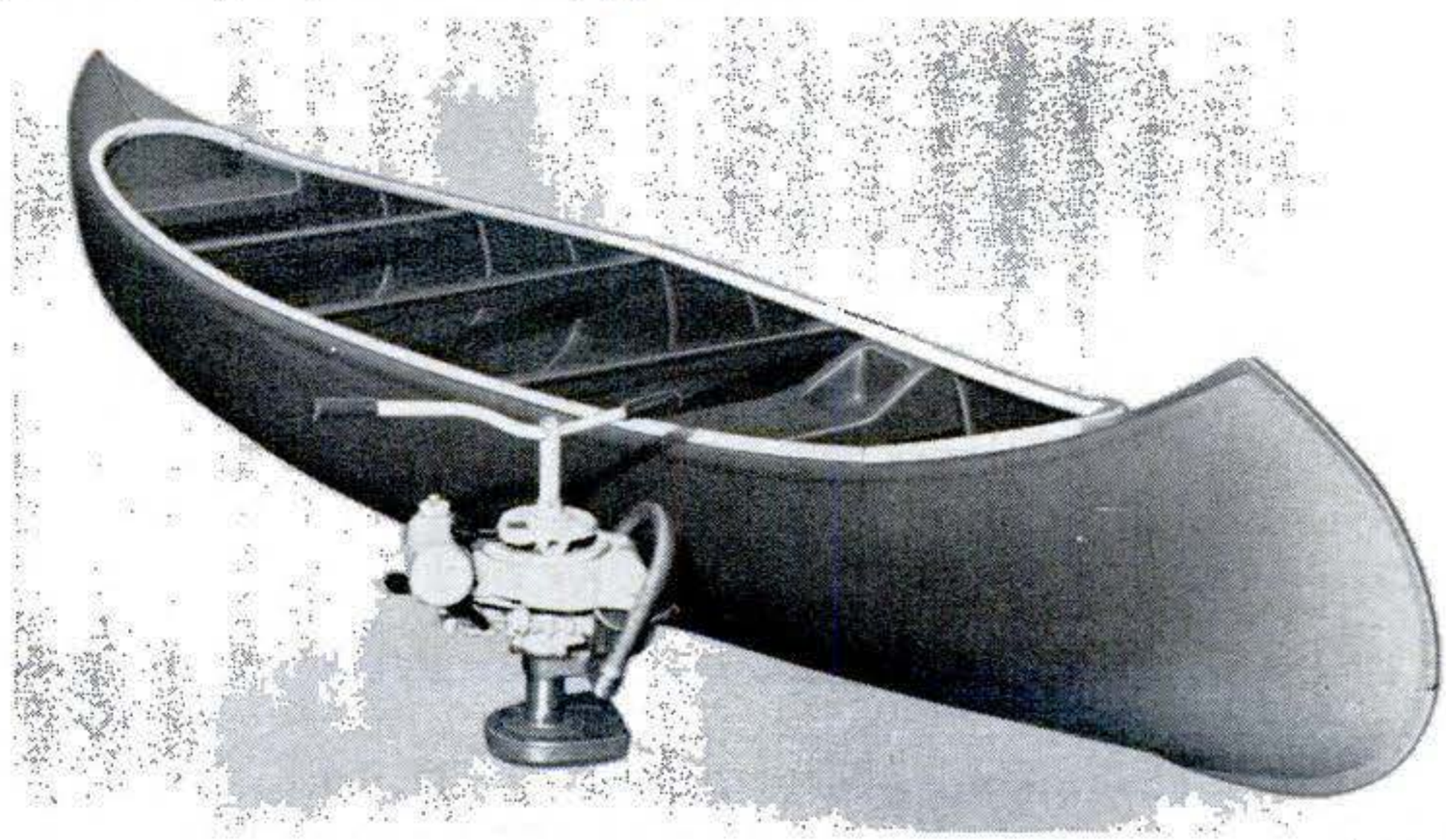
Tri-hull runabout in aluminum is beamy for plenty of lateral stability

She's called the Catalina Queen, runs 18 feet long, and has three-position front seats that fold to make a bed. Bucket seats are fitted aft. Her beam is 87 inches, hull depth is 42 inches, and her weight is 1,930 pounds. She takes stern-drive power plants from 120 to 225 hp.—enough to tow several skiers or haul sizable fishing parties. Aluma Craft Boats, 1515 Central Ave. N.E., Minneapolis 55413.



Paddle out with this canoe, and let jet power bring you back

A new jet-powered canoe of plastic should delight the sore-muscle crowd. An inboard motor mounted just forward of the stern drives a jet pump projecting only two inches below the keel. The unit gives you full 360-degree steering, causes no noticeable drag when you're paddling. Motors are 3½, five, and seven hp. for 15- and 17-foot canoes. Technical Products, 1161 Gray Fox Rd., St. Paul, Minn.



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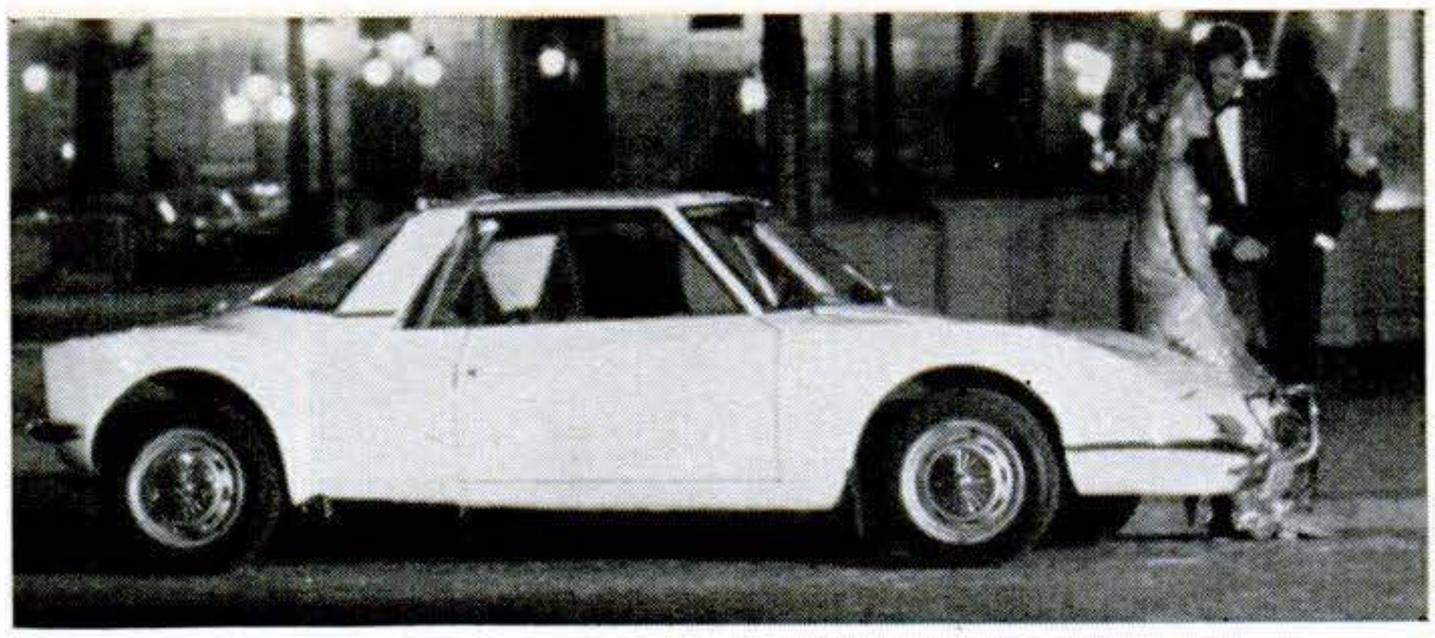
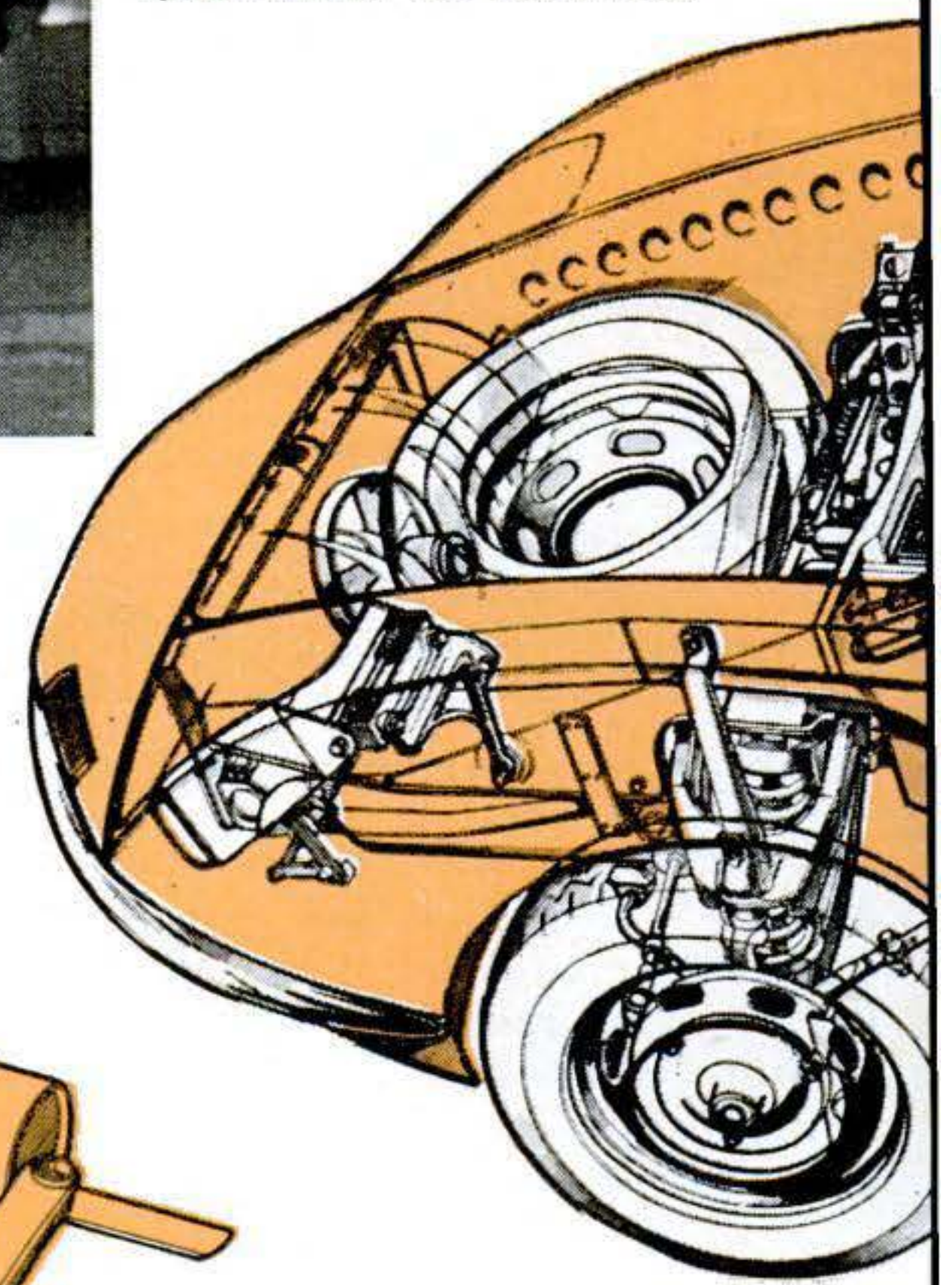
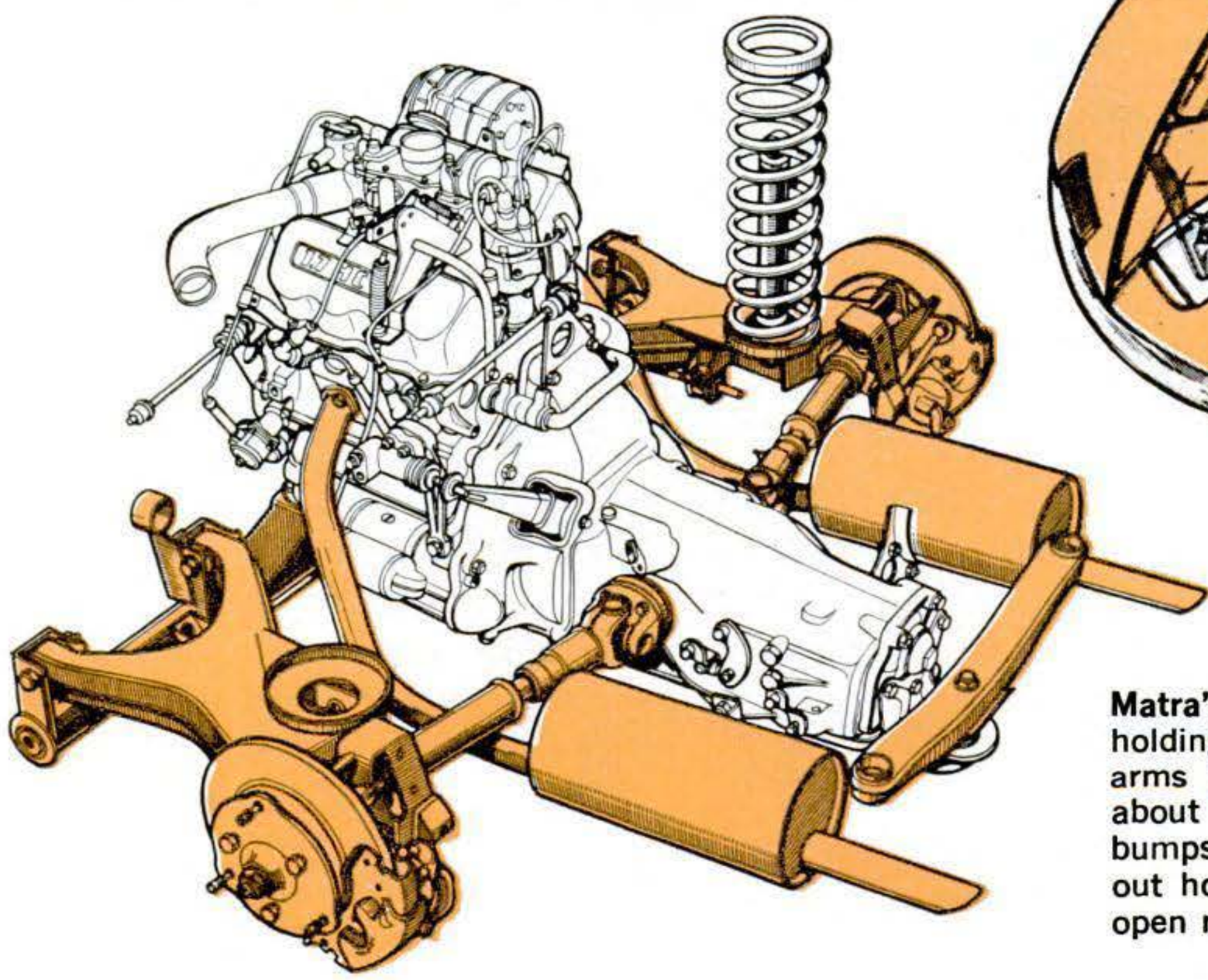


Does it have a trunk? Yes, in the tail, with room for four suitcases. The spare wheel takes up all the space under the low hood.





Matra's design for maximum road-holding includes rear-wheel control arms that keep camber angles just about constant as the car goes over bumps or around curves. Can't figure out how you get at the engine? Just open rear window—it's hinged on top.

New French Sports Car Has Midships Engine

Combine a racing-type chassis with a mass-production Ford engine—you have a Matra 530

By JAN P. NORBYE / *PS Automotive Editor*

If some uninformed TV commentator refers to Grand Prix, Indy, Can-Am, or Le Mans racing cars as having rear engines, you know he's wrong. Sure the driver sits ahead of the engine, but these cars are not rear-engined. They have midships engines. There's a world of difference. The rear-engine configuration used in VWs and Corvairs tends to introduce directional instability. The midships engine makes for a stable car with high handling precision and ultra-quick steering response.

I drove my first midships-engined sports car—a Cooper with a Coventry Climax engine—as long ago as 1956. It was a competition car, and the world is still waiting for a low-priced production sports car with central engine. The Matra comes closest, with a price tag of about $3,200 in France.

I was able to test-drive the Matra at Montlhéry race track outside Paris not long ago, and was impressed with its handling at all speeds. The steering is remarkably quick at under two turns, lock to lock, but never heavy.

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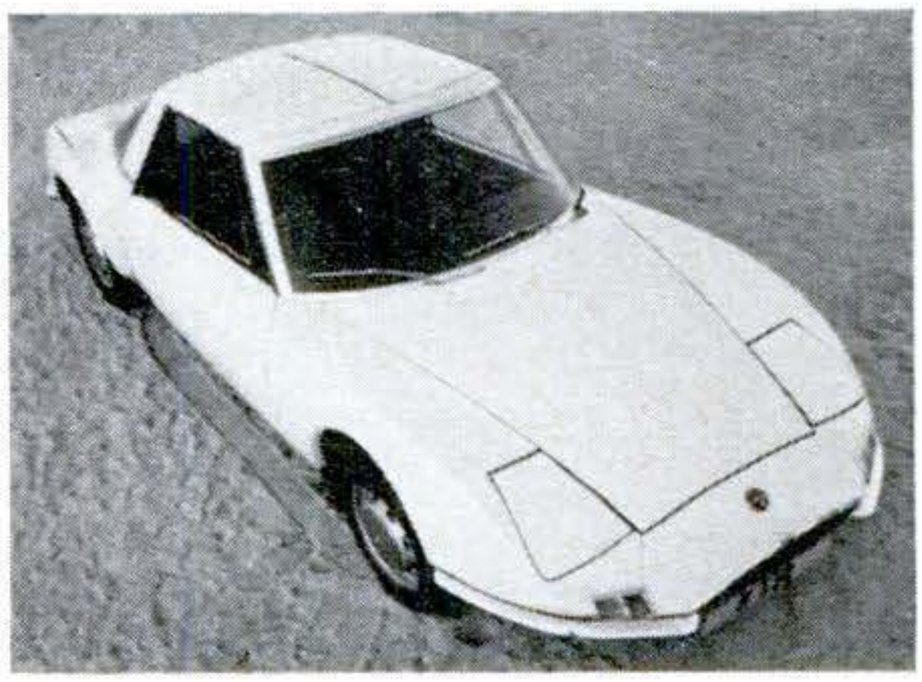
The suspension is softer than in a racing car, for a good ride on poor roads. The body is not free of roll in hard cornering, but the wheels don't lose their grip (radial-ply tires are standard). I'll be surprised if the Matra does not become one of the most copied sports-car designs in the coming years.

Top speed, Matra claims, is 107 m.p.h. —pretty good for a 114-cu.-in. 85-hp. V-4. The engine, built by Ford of Germany, is based on the power unit that sat amidships in the Mustang I—an experimental Ford that I drove in the summer of 1962. Ford of Germany wanted to build it, but the project was killed. Now Matra has revived the idea and put the 530 into production.

This new V-4 normally drives the front wheels of the Ford 17 M, riding way up in the nose. Matra moved it back until the transaxle is level with the rear wheels instead of the front ones. That way the standard transmission can be used (if the engine were turned around, you'd get one forward speed, four reverse). The independent rear suspension is a Matra design, derived from Matra's successful racing cars. For more information on the Matra 530, write to Luigi Chinetti Motors, 780 11th Ave., New York, N.Y. 10019.



Facts on the Matra 530

DIMENSIONS (inches)

Wheelbase	100.8
Front track	52.8
Rear track	53.15
Length	163.8
Width	61.2
Height	48.0

ENGINE

Type	60° V-4 OHV
Displacement	114 cu. in.
Power @ r.p.m.	85 @ 4,800
Torque @ r.p.m.	92.4 @ 2,600

CHASSIS

Transaxle	4-speed manual
Final drive ratio	3.56:1
Brakes	all disk
Steering	rack and pinion

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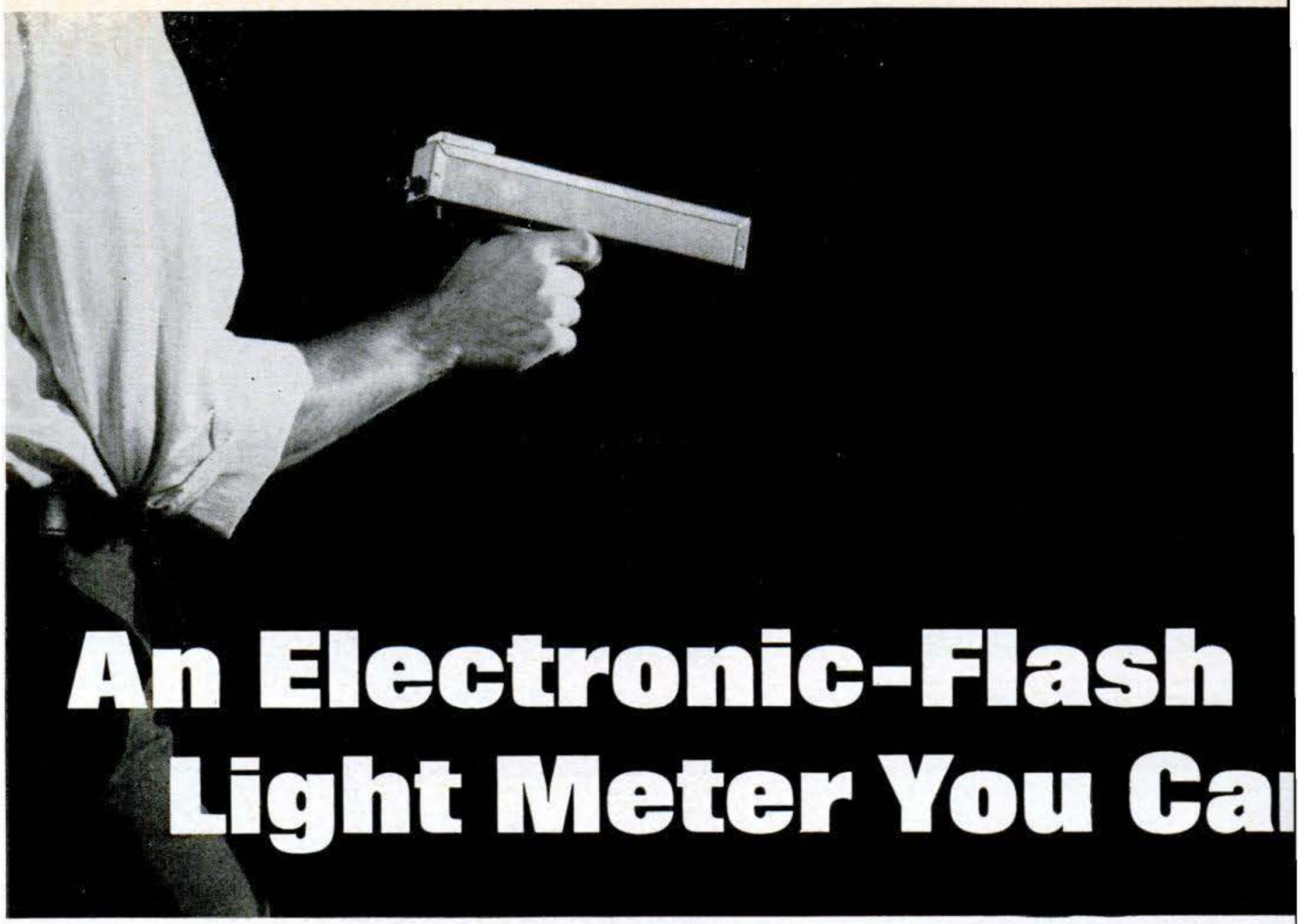

An Electronic-Flash Light Meter You Ca

This ballistic photometer does a job the ordinary light meter can't handle

By RONALD M. BENREY

One big trouble with an electronic flash is just that—the intense burst of light it produces is over in a flash. And that leads to a problem: How can you measure the quantity of light the burst contains?

There have been dozens of times when I've wished I could "read" the light output of my unit with an exposure meter. For example:

- After I've fired off 30 or so flashes, and the unit's battery pack is weakening. I want to know if the 31st flash will be substantially weaker than "normal."
- When I'm photographing a wide subject. I want to know if the beam intensity is uniform across the subject's surface.
- When I have a suspicion that the unit is on the blink. I'd like to be able to compare the actual light output with the "normal" output.
- When I photograph an unusually light or dark subject. I want to know if the nominal guide number still applies.

Obviously, a conventional exposure meter can't answer these questions—it simply can't respond to the less-than-1/1,000-second duration of the burst of light.

Happily, there's an unconventional exposure meter that can do the job: It's called a "ballistic photometer." This unique device actually measures the total light energy contained in a brief burst of electronic light, and then literally stores—or "remembers"—the measurement for several seconds, giving you ample time to read it.

How it works. The heart of the circuit is a vacuum phototube (Q1 on the schematic and pictorial diagrams). When light strikes its photosensitive cathode, an electric current can flow through the tube. The higher the light level, the greater the current flow.

In this circuit, the phototube is wired in series with a capacitor, C, a push-button switch, S1, and a 90-volt DC bat-

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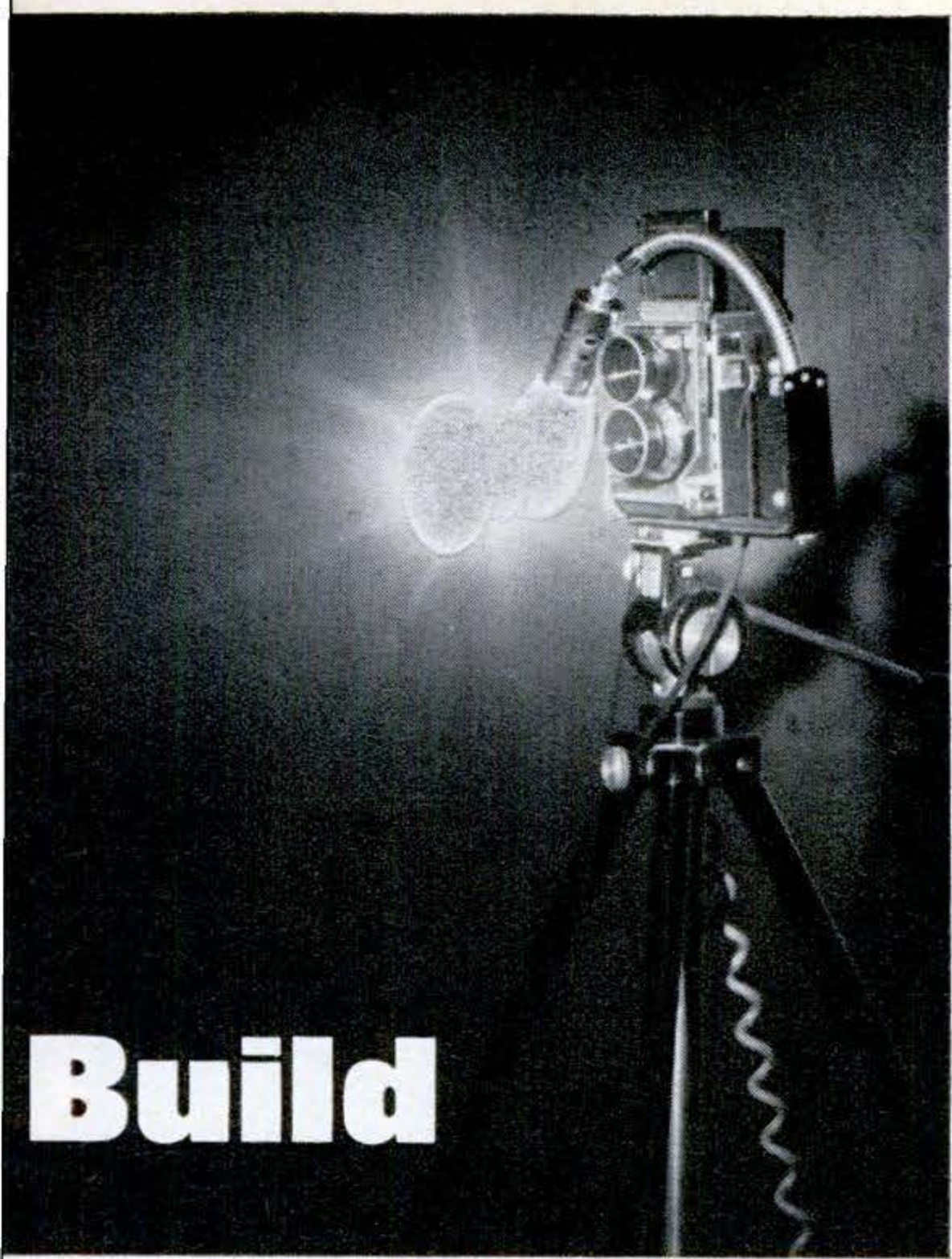
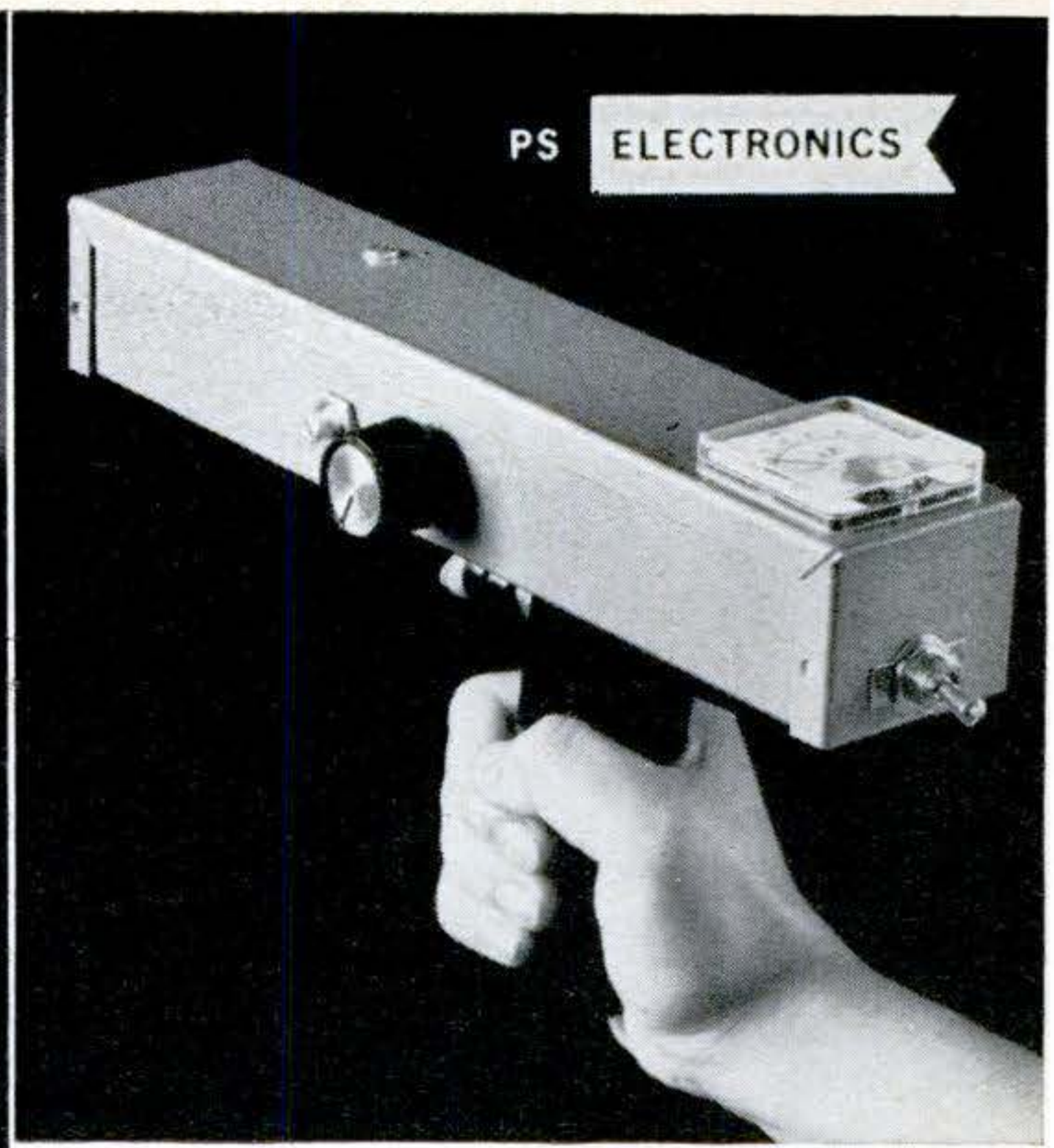


Build



Ballistic photometer takes the place of commercially built photometers costing hundreds of dollars. You can build this homemade unit for less than $20. It will tell you everything you need to know about your flash, to insure perfect exposure regardless of battery condition, beam width, or subject reflectivity.

tery pack, B1 and B2 (wired in series). The burst of light striking the tube causes current to flow into the capacitor, building up a charge on its plates. The voltage measured across the capacitor (after S1 is opened) is proportional to the total light energy contained in the flash.

The remainder of the circuit is a special type of electronic voltmeter (built around field-effect transistor Q2) that monitors the capacitor's voltage, and produces a proportional reading on panel meter M.

Power switch S2 controls the 8.4-volt mercury battery B3 that powers the voltmeter circuit and, in addition, discharges the capacitor when the switch is turned off. This is necessary to prepare the capacitor for a new reading before each measurement—in effect, turning S2 off resets the voltmeter circuit.

Building it. Make the housing from a 2"-by-1½"-by-10" aluminum minibox. For convenience, add a low-cost pistol grip to the bottom, as shown. Note that S1 is mounted inside the grip, so that it acts as a trigger switch. To mount it, first pry away the grip's baseplate, and discard the camera-mounting screw. File away the finger notch closest to the base, and drill a ⅜" hole for the switch shaft.

The phototube is mounted in a socket that, in turn, is mounted on a small piece of phenolic board, which is held to the case with an angle bracket.

Because the phototube is mounted in line with the minibox, a simple optical system is required to direct light toward its photosensitive cathode. This is just a small rectangle of glass mirror (use a glass cutter to cut a section from a single-sided purse mirror) that is cemented to the case, as shown. Light enters the box through a ¾" round hole cut in the front, and bounces off the mirror into the phototube.

Because of the tight quarters, there's no room for battery holders. Instead, the three batteries are taped together to make a battery pack, and the pack is cemented in place. Solder connecting wires directly to the battery terminals. Current drain is so slight that a set of batteries should last well over a year.

Using it. The two operating controls are R1 (zero set) and R2 (fine sensitivity). Setting R1 is a bit tricky be-

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cause of the circuit's natural tendency to drift slowly when it is operating. The idea is to adjust R1 so that the meter reads 0 the instant that switch S2 is turned on.

For most measurements, set R2 approximately to midrotation—we'll talk about the exceptions to this later on.

Here is how the four measurements we spoke about earlier are made. Keep in mind when you use this instrument that the meter readings indicate relative light levels, not absolute measurements.

1. To determine the decline in light output as the batteries in your flash unit age, set up the flash unit on a table about 15 feet away from you. Point the photometer at the flash unit, flip S2 on, press S1, and have an assistant fire the flash. Release S2 immediately, and quickly note the meter reading. Turn S2 off to discharge the capacitor, and begin again.

Jot down the sequence of readings, and after the equivalent of a full 36-exposure roll of film (36 flashes) note the difference in readings among the different flashes.

A 10-percent drop between the first and last flash readings, for example, means that you must reduce the guide number by 10 percent as you near the end of a roll of film.

During this test, if the meter needle goes off scale, reduce the circuit's sensitivity by increasing the value of R2. If the needle still goes off scale, block off part of the phototube's light port with a piece of black tape.

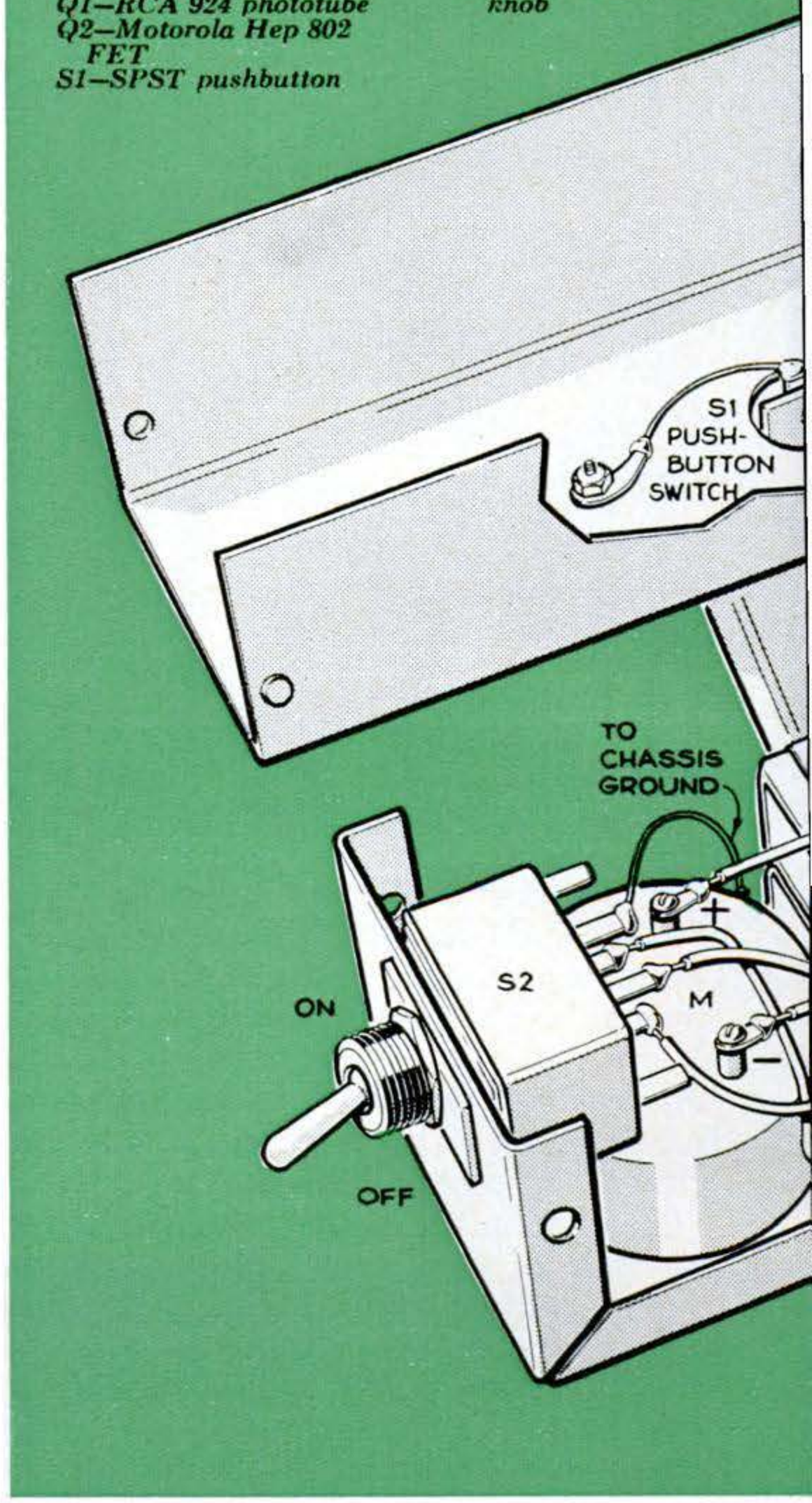
2. To measure the flash unit's beam width, set up the unit as above. Only this time walk around the unit, and point the photometer at the flash from several off-axis angles (say, 10, 20, 30, and 45 degrees). The off-axis angle at which the meter reading drops to half of its on-axis value is the outer boundary of the unit's beam width.

3. Similarly, you can detect a drop in light output at any time, simply by comparing an on-axis reading with an earlier measurement made under similar conditions.

4. There are several ways to evaluate the correctness of your flash unit's guide number on various subjects. Here's the technique I use:

PARTS LIST

R1—5,000-ohm carbon pot
R2,R3,R4—2,000-ohm carbon resistor (½ watt; 5%)
R5—2,500-ohm carbon pot
C—2-mfd., 100-volt plastic capacitor
Q1—RCA 924 phototube
Q2—Motorola Hep 802 FET
S1—SPST pushbutton switch
S2—DPDT toggle switch
M—0-50-microamp miniature meter
Housing—2"x1⅛"x10" aluminum mini box
Misc.—mirror, pistol grip, knob



First, photograph several average scenes inside your home—anything is okay, as long as it includes an equal proportion of light and dark objects. Use the manufacturer's recommended guide number.

When the film is developed, choose the scene that looks the most perfectly exposed. Next, aim both your flashgun and the photometer squarely at the scene and fire the flash several times, taking readings each time. The first flash should be made with the photometer and flash unit

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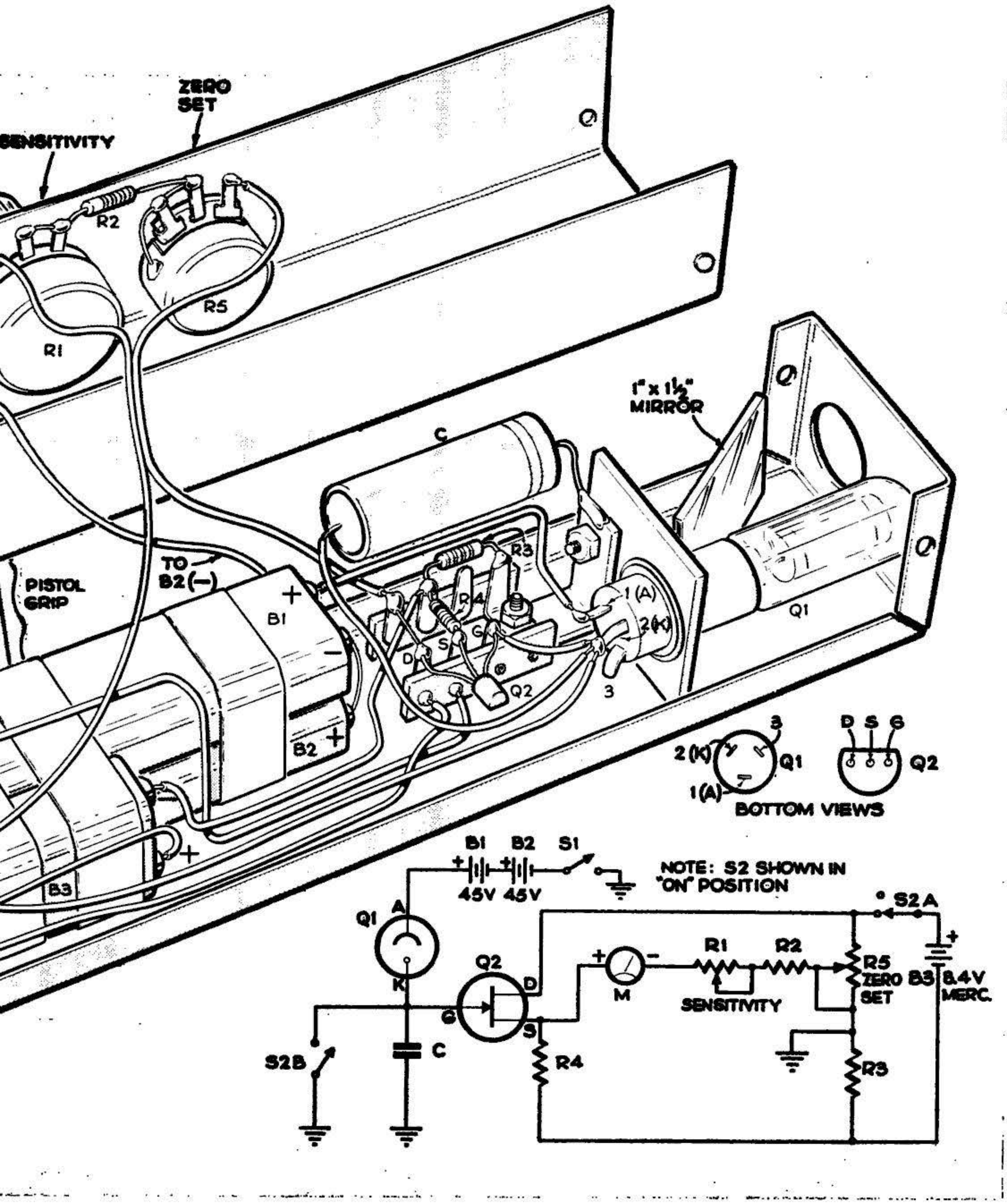

about four feet from the scene, the second about five feet, and so on.

The idea is to find the flash-to-scene distance that produces a meter reading of about half-scale (25 on the scale).

If the reading is close, you can bring it directly on the mark by adjusting R2 slightly. *Important:* Note the exact position of R2, and make an index mark on the case so that you can quickly return R2 to this position.

Now, if you are confronted by an unusual subject, simply bring the flash unit and the photometer to the distance determined above, set R2 to the index mark, and fire the flash. The proportional difference between the actual meter reading and midscale is equivalent to the proportional difference between the nominal guide number and the "effective" guide number for this subject.

Using our ballistic photometer in the four ways described will get you top usefulness from your electronic flash. It should certainly show up in the quality of your photographs. PS

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WHAT'S NEW

ELECTRONICS

Your voice answers phone with device that also takes messages

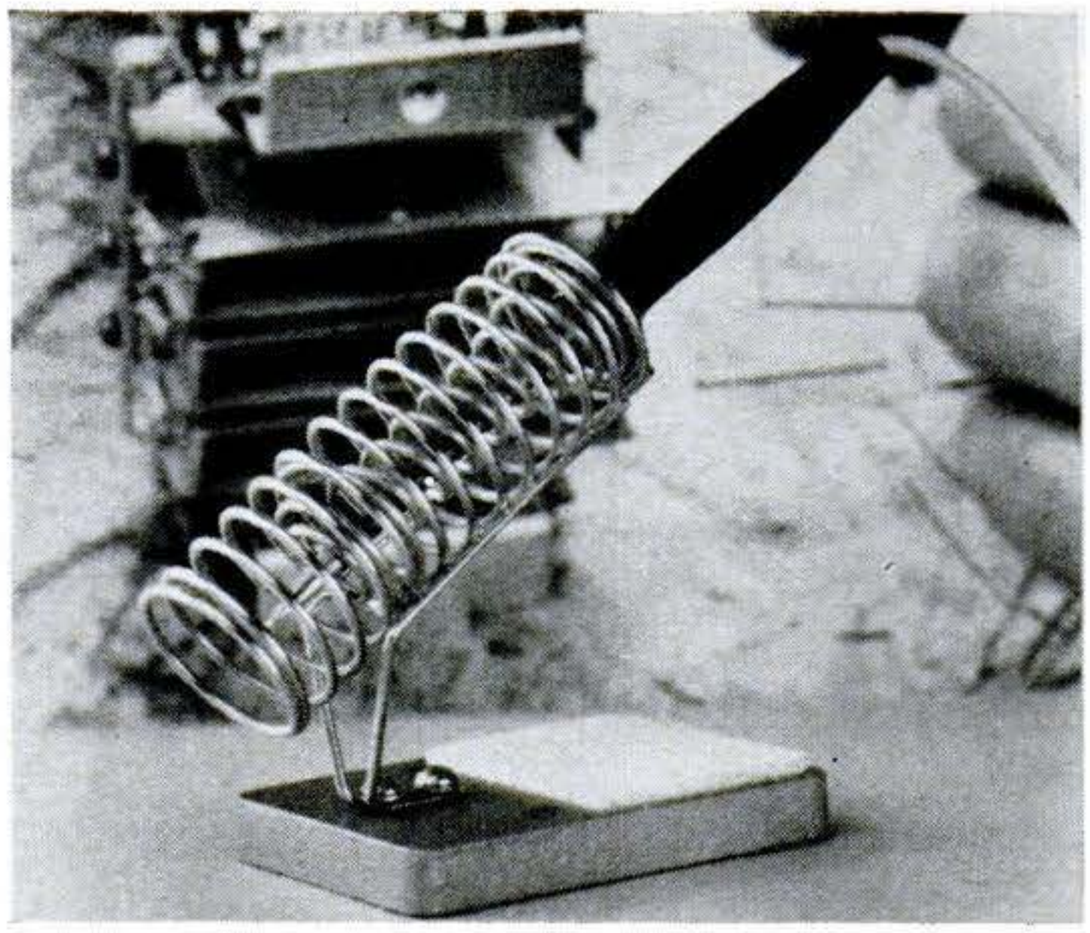
The telephone-answering system shown at right responds to your incoming calls with a message to the caller that you have prerecorded. It then takes the caller's message on any standard tape recorder, allowing 60 seconds for outgoing and incoming messages. The machine then automatically "hangs up," ready to take the next call. Model 4100, from Crown-Industrial Suppliers, 755 Folsom St., San Francisco 94107, is $119.95.

Electronic musical instrument you can build

Here's a 32-note keyboard instrument with selector-switch control of six different "voices" for musical effects from normal wind and brass to weird, way-out sounds. It plugs into any guitar, PA, or hi-fi amplifier. Called Tunesmith, the instrument sells for $149.95 (kit) or $189.50 (assembled). Schober Organ Corp., 43 W. 61 St., NYC 10023.

Guard unit detects faulty circuits

This indicator plugs into any standard three-wire receptacle. Circuit faults are pinpointed by three lights. $5.95. Dearborn Wire and Cable Co., 3333 W. Ohio, Chicago.



Soldering-iron holder prevents overheating

A coiled holder allowing heat to escape prevents damage to tip and heater element. It also protects user from burns. With base and tip-wiping sponge, $11.20 from GE.

TO REMOVE SECTION for loose-leaf binding, open magazine wide at this page, rest it on table, run your thumb firmly along center fold. Then pull out the sheets gently, one at a time.

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PS EXTRA! 16-PAGE SPECIAL REPORT

BRAKES for your car

Your car is only as safe as your brakes. Here's how to buy them, use them, and maintain them

By RICHARD DAY

How safe are your brakes? They work fine around town, sure. But how would they react in an emergency stop on the freeway? One nationwide check made in 1967 turned up 23,000 cars in use with unsafe brakes. Compulsory vehicle-inspection records show even worse statistics. Some 30 percent of passenger-car brakes were found unsafe only six months after a previous semiannual city inspection had passed them. Must you wait until your car is tested—or is involved in an accident—to learn what shape your brakes are in?

To get the answers to these and other questions about brakes, I went to the men who repair them, make the tools for them, design them, and test them. I started off with a long list of questions and did not stop until I had the complete story on brakes.

Now I'll tell you:

- How you can use your brakes for safer stops.
- How you can give your car better brakes.
- What the best brake linings are.

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PS Extra: BRAKES

- What a good brake job is, where you can get one, and how much you'll have to pay for it.
- What Detroit is doing about making better brakes.

At first there seemed to be vast disagreement. Designers thought one thing, service people another. But soon I saw that there was underlying agreement among them all.

A brake is simply a heat machine. It transforms energy stored up in a moving automobile into heat. The amount of heat varies according to the square of the speed. In a single stop by a 4,000-pound car from 70 m.p.h., the temperature of brake drums and rotors can be boosted 200 degrees. Pile several stops on top of each other without time for cooling, and your brakes may begin to smoke.

If cars were designed around an ideal brake, the brake would be mounted outside the wheel where plenty of cooling air could flow around it. Wheels would be large to permit large brakes. They'd go at least 100,000 miles between relinings. Maintenance would be so simple that anyone could do it.

Some of you wouldn't buy this car because it would cost a lot and look kooky in front of the house. But it would have darned good brakes.

Two types of wheel brakes are in use today—drums and disks. In drum brakes, a pair of curved, lined shoes are pushed outward against a turning drum to stop the car. In disk brakes, opposing flat lined shoes or pads are squeezed together to stop the revolving rotor between them.

Wheel brakes are actuated hydraulically. Brake fluid in the hydraulic system is displaced and pressurized, pushing out pistons in all the wheel cylinders. The pistons force brake linings against the rotating parts. You stop.

What Do the Pure Oil Trials Mean?

Each year the Union/Pure Oil Performance Trials throw lots of publicity on new car brakes. POPULAR SCIENCE has covered them since 1963. The test cars are bought anonymously and prepared under strict NASCAR supervision.

The stopping-distance figures show that some cars have made the final hot-brake panic stops from 65 m.p.h. in well under 200 feet. Other cars have needed well over 250 feet to stop. I asked some of Detroit's most noted brake experts why. None wanted to be quoted. All stuck to Detroit's standard reply: "Pure Oil Trials aren't good brake tests."

Sour grapes? Hardly. Three had winning cars in the Trials. They chuckled when I pointed this out. "The Trials were more a test of tires than brakes," one told me. "All the test stops were locked-wheel stops. Once the wheels are locked, that's all that the brake lining can do. This isn't much of an indication of brake performance. The linings would have had to be very poor *not* to hold." (What they neglected to mention was that after 10 warmup stops, certain cars were no longer able to lock their wheels, with any amount of pedal pressure.—*Ed.*)

Dick Dolan, Trials head man, speaks in defense of his brake tests.

"Locked-wheel stops are what most

Should those self-adjusters be removed?

Most cars built since 1962 have self-adjusting brakes. Too many mechanics tend to blame all brake troubles on the self-adjusting mechanisms and often remove them. From then on, the owner's safety may be endangered. Brake-pedal travel is designed for self-adjusting brakes that keep a high pedal. No reserve of pedal travel is provided for brakes with more than ideal shoe-to-drum clearance.

The problem is insidious on cars with dual master cylinders. Pedal travel will increase when stopping on one system alone. If the automatic adjusters have been removed, the driver may not see any danger until too late.

If a rock tears out a rear brake hose, and you have to stop on the front brakes, the loose front shoes can run you out of pedal travel before the brakes take hold. Think twice before you let anyone put manual adjusters on your brakes.

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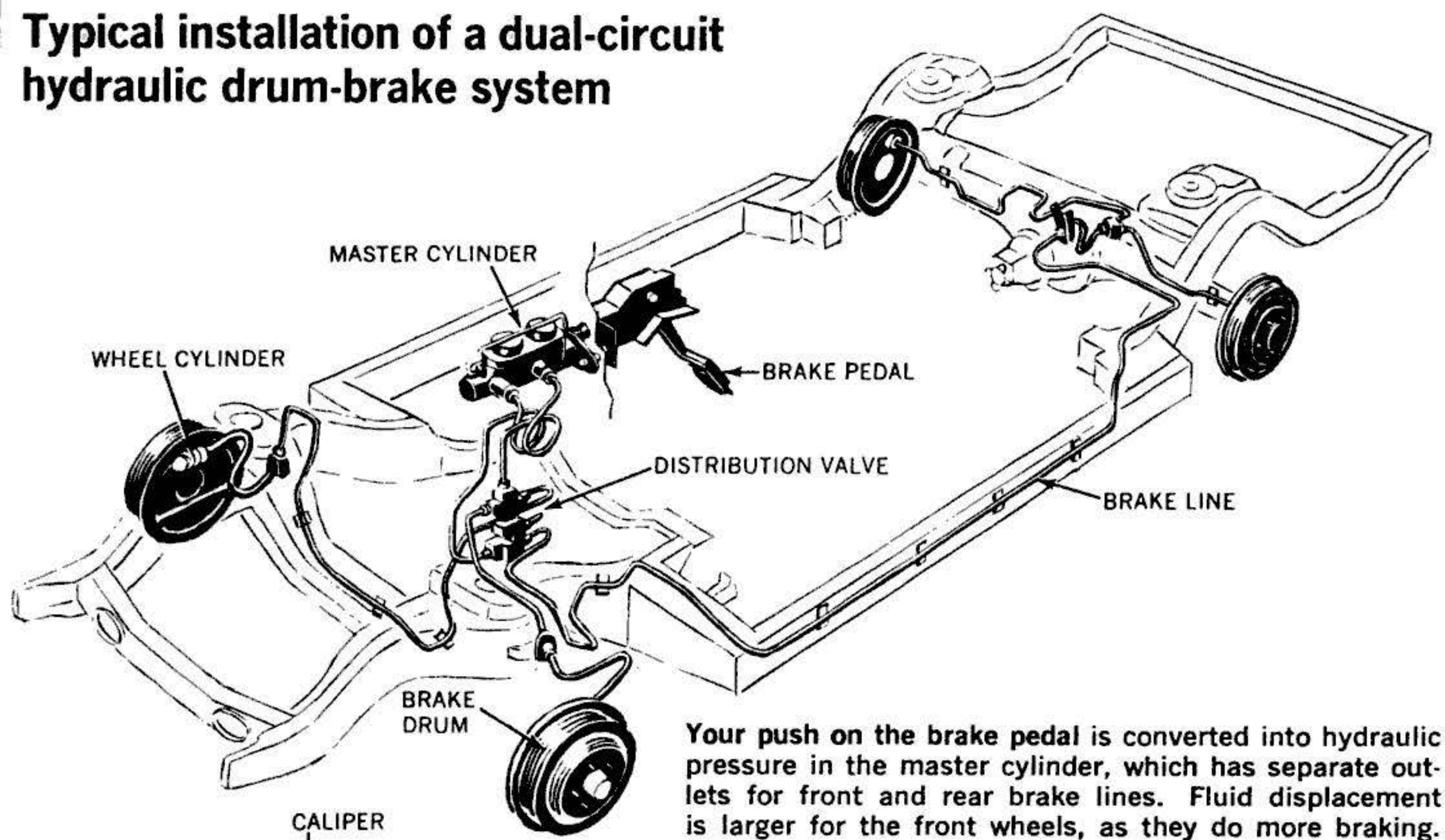
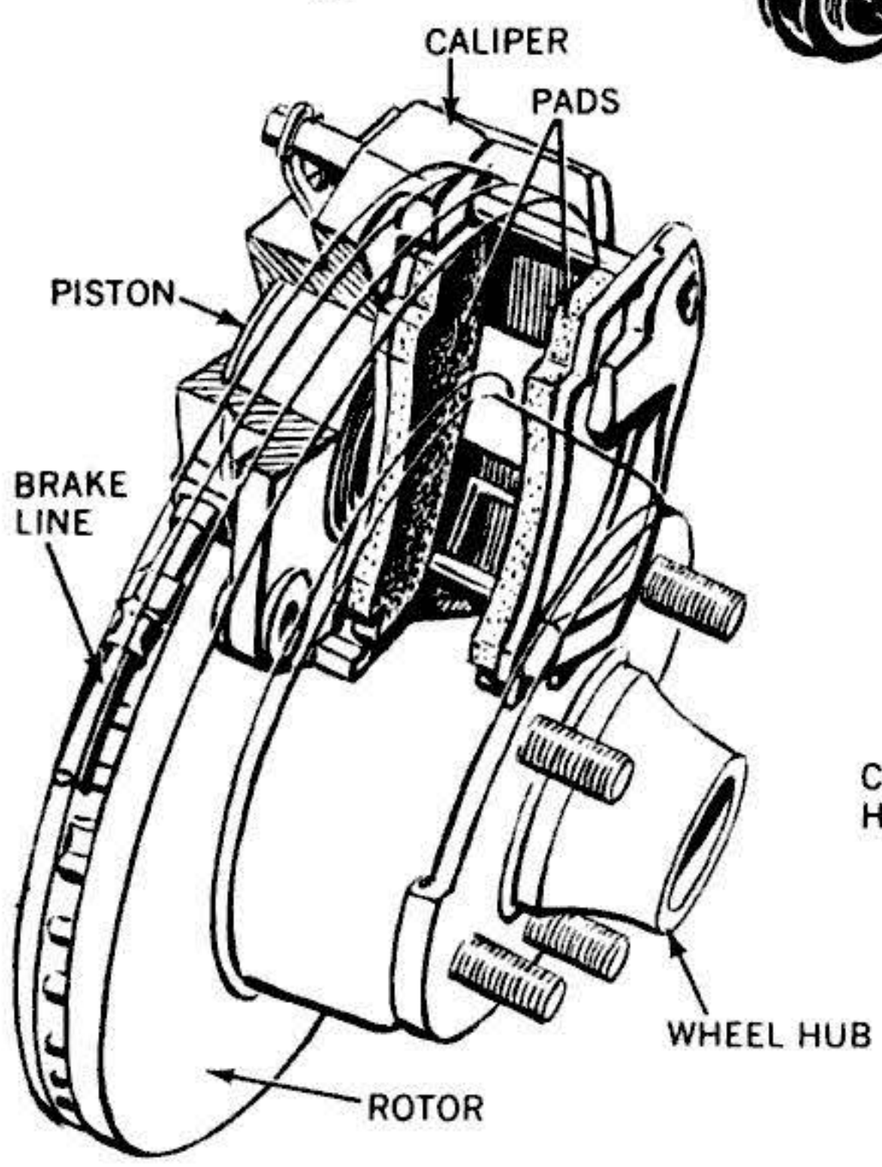
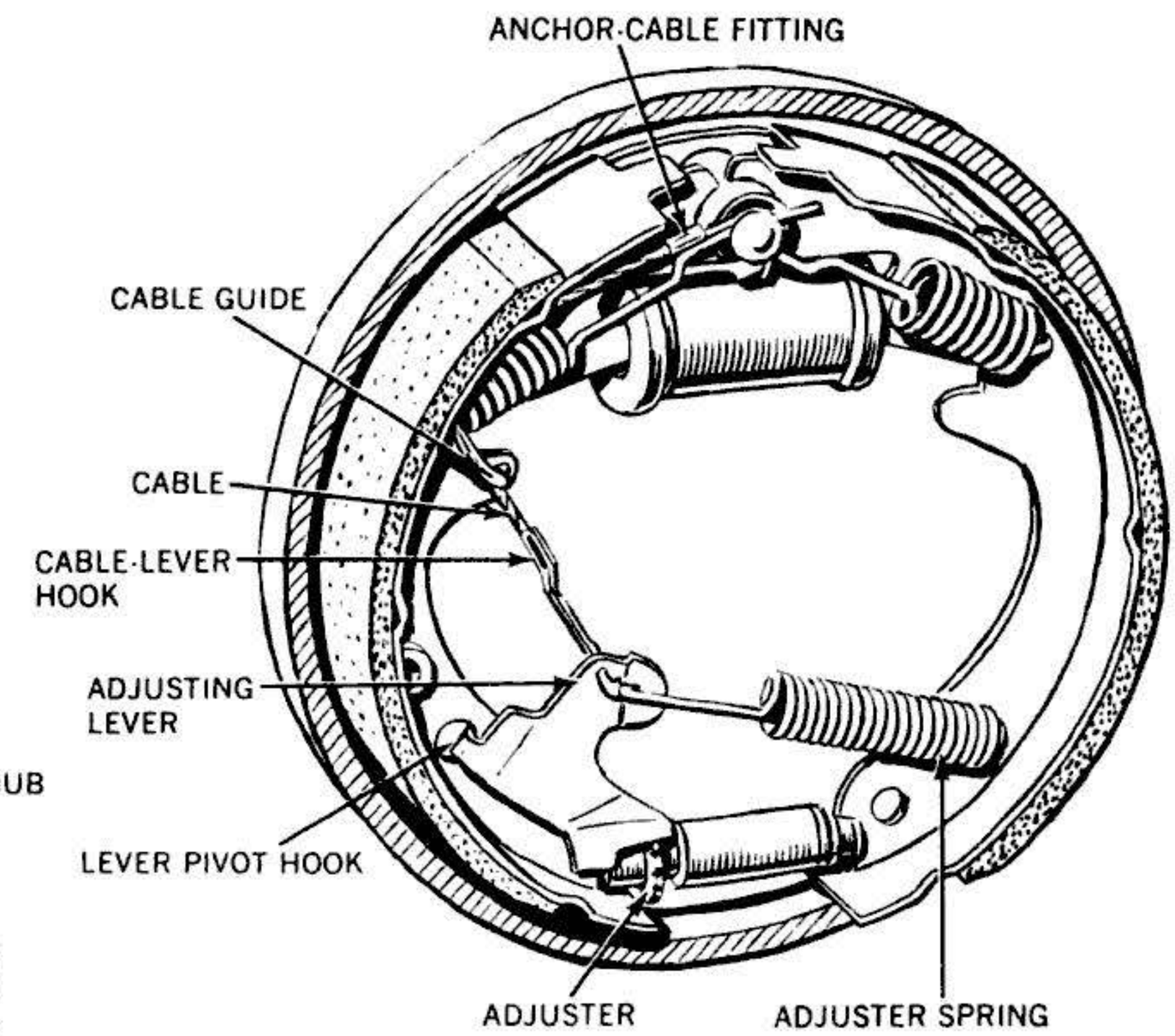
Typical installation of a dual-circuit hydraulic drum-brake system



Your push on the brake pedal is converted into hydraulic pressure in the master cylinder, which has separate outlets for front and rear brake lines. Fluid displacement is larger for the front wheels, as they do more braking.





Disk brakes (above) are rapidly replacing drum brakes (right) on front wheels. This is a single-piston, floating-caliper disk brake. The rear duo-servo drum brake also works, mechanically, as parking brake.

people make when they get into emergency situations," he says. "Our directions to the drivers say stop as quickly as you can. They don't *have* to lock the wheels, but most choose to. They do the same as you or I would do if someone's kid jumped out between two parked cars. We stand on the brake, lock up all four wheels, and pray."

Dolan admits the Trials aren't the greatest brake test in the world. "They are a very accurately measured brake demonstration. The results are understandable without an engineering background. If there's a better test, we'd like to know about it," he concludes.

"*Is* there a good test of brake performance?" I asked the critics. All of them liked the Society of Automotive Engineers' J843A on-the-car brake-test procedure. It takes a week to perform. SAE's

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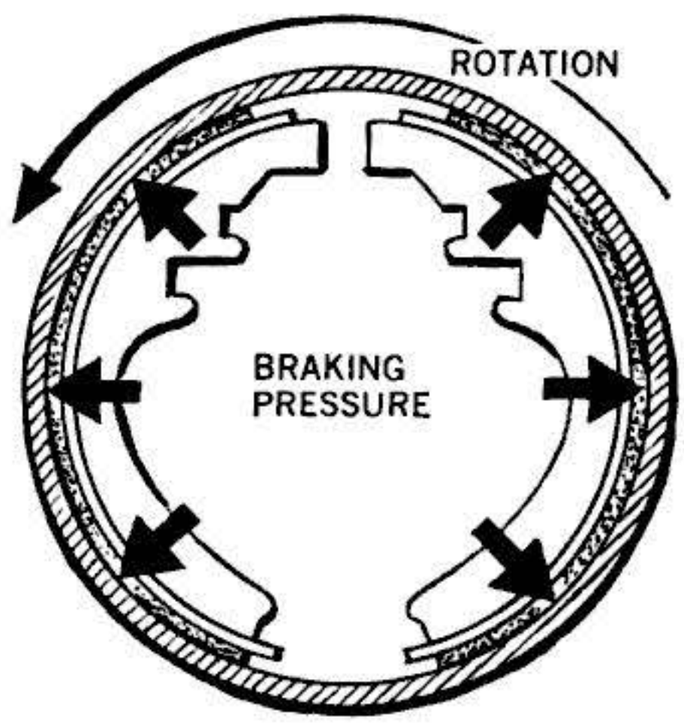
J937 states what levels shall be met during the J843A procedure. "It's as accurate and complete a test as there is," I was told. But results aren't published.

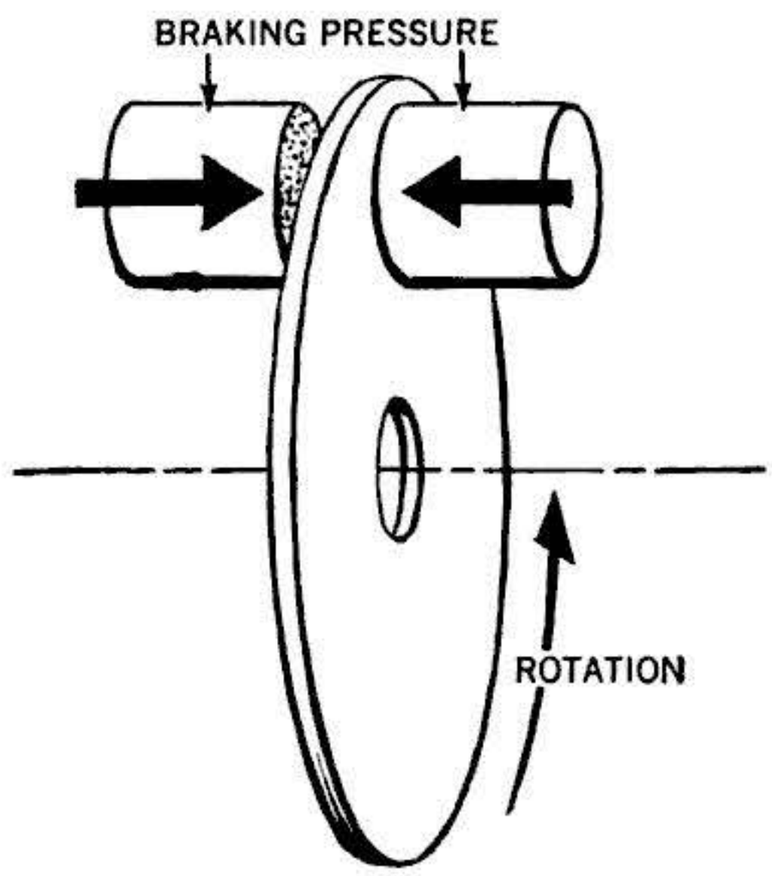
The effectiveness of brakes at low, medium, and high speeds is tested. Fade of the linings is determined. Any tendency of the brakes to pull during fade is recorded. Water-recovery characteristics are checked. The parking brake is tested.

"SAE J843A is the only valid brake test today, as far as the public is concerned," says Ed Naudzius of Chevrolet. Nearly everyone agrees. Naudzius was on the SAE Test Committee. The SAE test has now been incorporated into Federal Motor Vehicle Safety Standard 105.

Disk and drum brakes operate on different principles



Inside a brake drum, the brake shoes are forced outward, against the inner surface of the drum. The drum itself rotates with the wheel, while the shoes are attached to a backing plate, which stands still.



A disk brake works by forcing two friction pads held in a stationary caliper against a revolving disk. Line pressures are much higher than in drum-brake systems, and the risk of fluid boiling is greater.

How to use your brakes. You can get shorter stopping distances out of your car by knowing a few facts about how to brake under various conditions. The experts suggest these:

Use your brake as a last resort. If there's a way to steer out of trouble without braking, take it.

The best way to get the shortest stopping distance in a dry-pavement panic stop is to lock up all four wheels fast. Step on the brake hard and don't let up unless loss of control threatens to get you into greater trouble.

Stopping on slippery pavements like wet, oily blacktop may call for quick partial release of the brake pedal now and then. This is done as needed to maintain directional control.

Stopping on icy roads takes a different technique. Ross Wilcox of the Safe Winter Driving League recommends pumping the brakes. "The ideal would be to jab your brakes on and off very rapidly, about three to five times a second," he says. "This would keep the wheels rolling and help retain steering control." Actual tests show that few drivers can pump a brake pedal this rapidly. Once or twice a second is par. That's not fast enough. Locked wheels will stop you faster. Practice brake pumping on a deserted icy road or parking lot. If you can't do the fast-pumping bit, try to apply your brakes on ice just short of locking. This isn't easy either. Avoid locking your wheels on ice.

Don't drag your brakes down long grades. Shift to a lower gear. If the transmission's lowest range isn't low enough, snub the brakes repeatedly. A snub is harder than a light, steady brake application but lasts only a second. Your brakes may then cool between snubs.

Don't ride the brake. It wears the linings rapidly and is the chief cause of fade. What's more, it keeps the brake light on, confusing drivers behind you. With power brakes it may take as little as five pounds of pedal pressure to start the brakes dragging.

Whenever you drive through deep puddles, hold a light pressure on the brake. This will keep the linings dry so you

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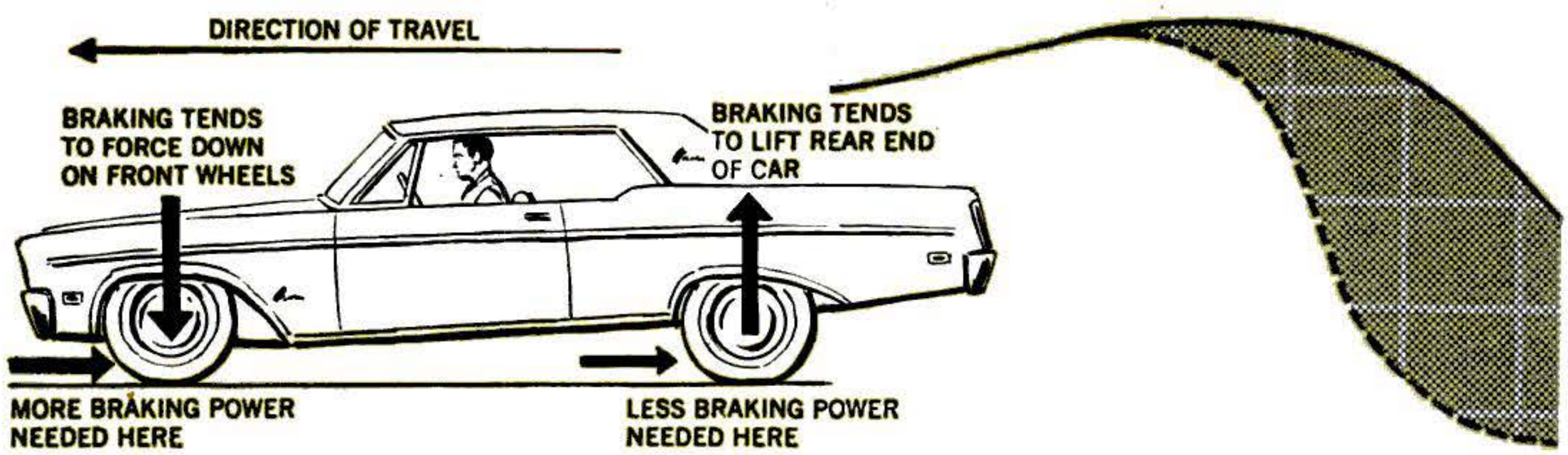
How brake requirements change while you're slowing down



As soon as braking begins, a forward weight transfer takes place. It's like removing load from the rear and adding it to the front. If front wheels did not get 65-75 percent of brake force, they would be working below capacity, and rear wheels would lock.

Fade is the name for what happens when the brake-lining material heats up to such a degree that its coefficient of friction gradually drops off, and higher pedal effort is needed. Linings fade at different temperatures and sudden fade is dangerous.

have brakes when you get out. If the linings get wet and lose stopping power, ride the brake moderately hard or make repeated snubs to heat up brakes and drive off water. Heat buildup should soon dry things out.

Breaking in brakes is important. Fast stops during a brake lining's early miles can ruin it. Avoid hard braking for the first 300 miles. Some say 500. Make gentle stops to introduce the lining to the drums. Break-in is needed not only on new cars, but on older cars with newly relined brakes.

Sock it to your brakes once in a while, during break-in as well as in later life. Cars that are driven around town with only gentle braking often balk and swerve when braked hard on a freeway. Resins in some linings form a slick glaze that covers the asbestos. Hard use removes it. John Winge at Bendix has a glaze-chasing method he uses periodically on his wife's car. "I take the car out on the highway and, when it's clear, make two or three normal stops from 60. This gets rid of any glaze." Some linings, for instance Cadillac's, glaze in severe service and high heat. Different restoration techniques are needed with these. "Current linings are formulated to prevent glaze," Winge adds.

"Don't set the parking brake after a hot, hard stop if you can avoid it," warns Ed Rust of Schmidt-Behrens Ford, Peotone, Ill. Others agree. "You'll make the hot drums oval and end up with a pulsating brake pedal."

How to Check Your Own Brakes

Brakes rarely fail suddenly. They usually warn you of impending trouble. Without spending a cent you can safely-check your own brakes.

- With your car halted, press hard (about 50 pounds) on the brake pedal and hold for 30 seconds. The pedal should remain firm and show no tendency to fall away from your foot. If it falls off, there may be leaks in the hydraulic system. Internal leaking within the master cylinder will not show loss of fluid. Other leakage will.
- Pump the pedal and feel for sponginess indicating air in the hydraulic lines.
- Check brake-pedal free play. There should be 5/16 to 7/16 inch of play in a manual system. Power brakes usually have no adjustment for free play.
- Measure the amount of pedal travel left after the pedal is depressed. With self-adjusting brakes there should be three inches, half that on power brakes with the engine running.
- Look underneath for signs of hydraulic leaks, especially at the bottoms of the backing plates.

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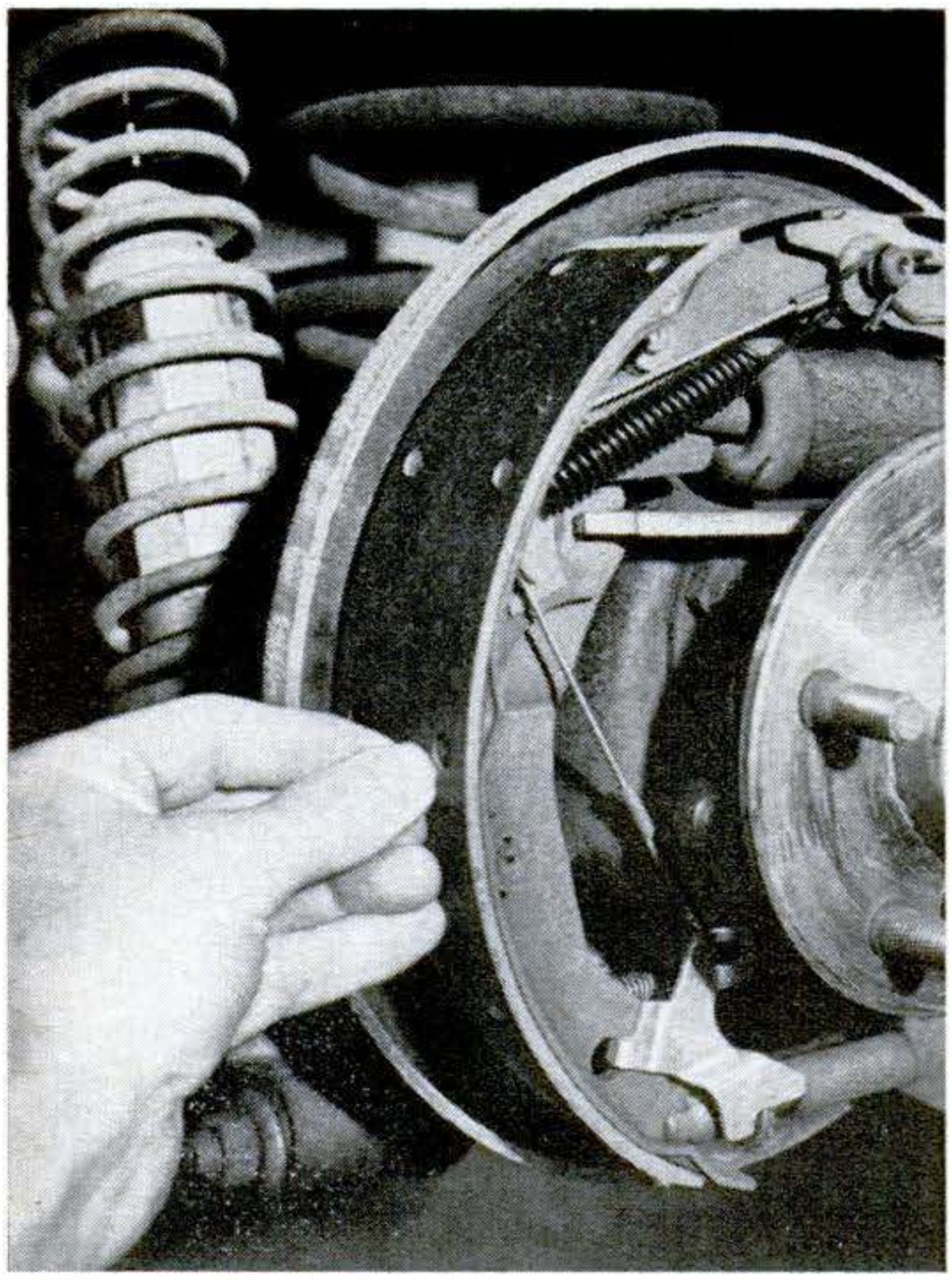
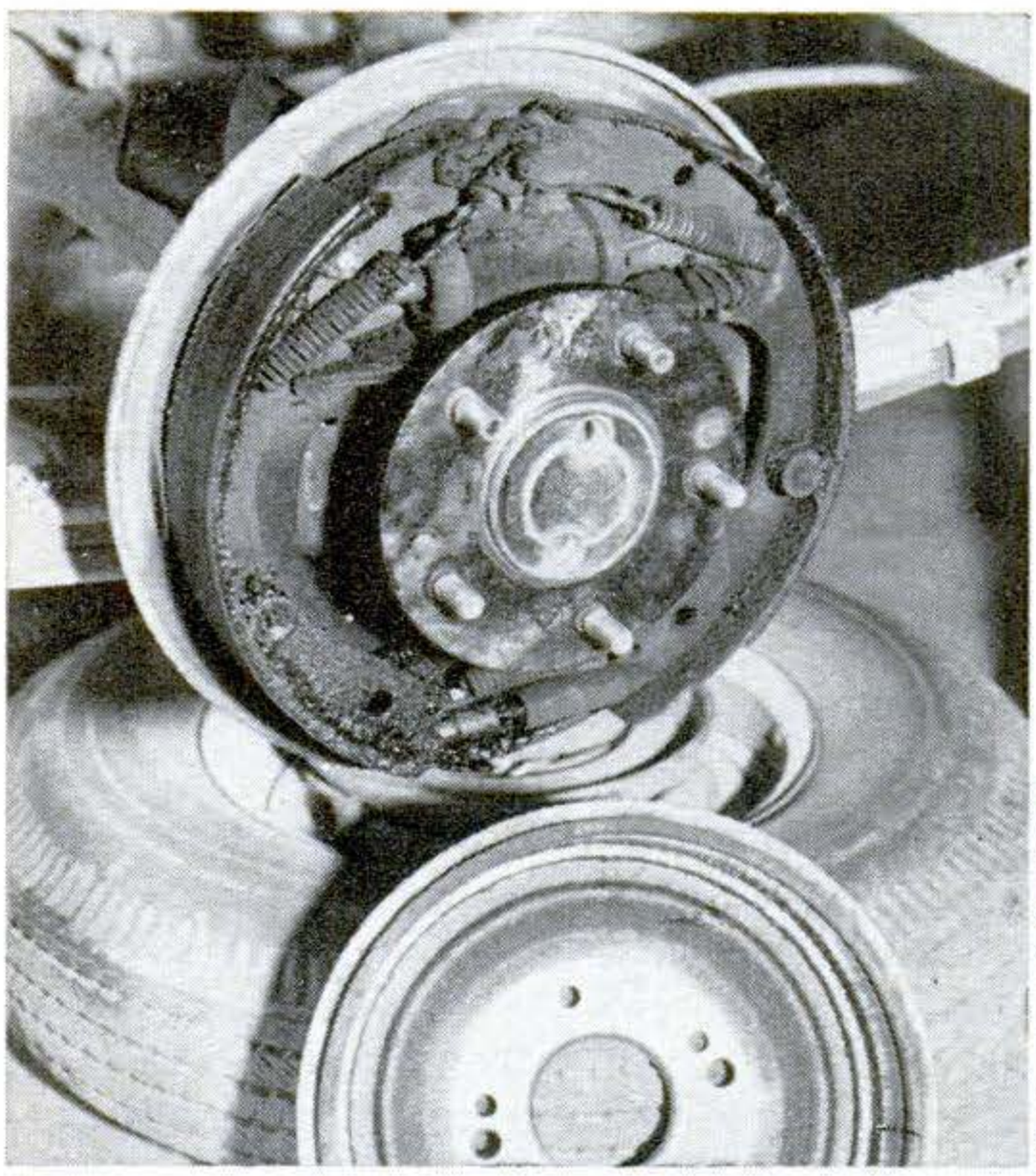


When a brake lining is worn to within 1/64 inch of the rivet heads, it's time for relining. Check yours at least once a year. Minimum thickness on bonded linings, before they need replacing, is 1/32 inch.

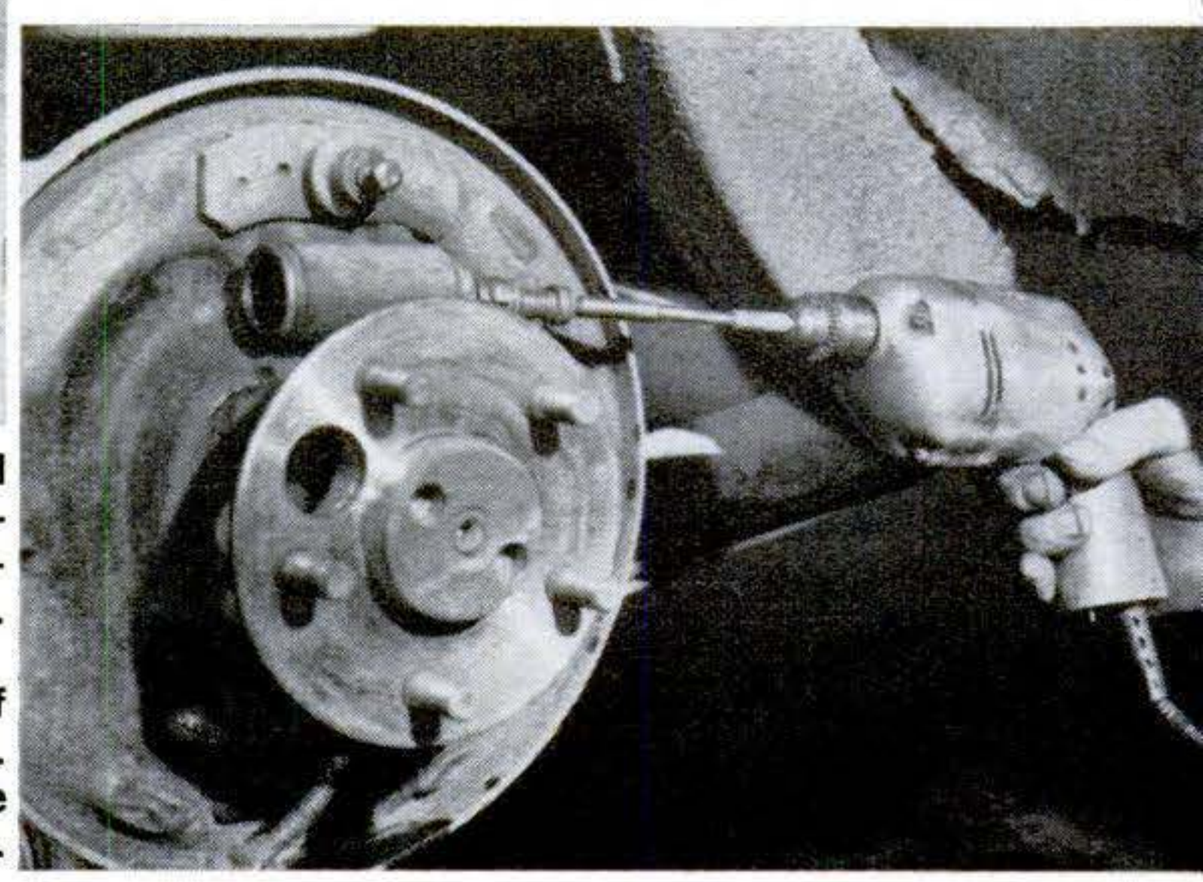


A leaking grease seal on wheel bearing has ruined these linings. Both must be replaced. Bonded linings are usually sold as a unit, with shoes. Don't forget to get a new grease seal, or it will happen again.

- Make sure that wheels, tires, shock absorbers, axles, fender aprons, exhaust systems, and suspension parts aren't rubbing against any of the brake lines or hoses.
- Check the master-cylinder fluid twice a year.
- Road-test at 45 m.p.h. for brake pull. Don't forget that front-wheel misalignment can cause brake pull, too. Be sure traffic behind is clear—then try to slide your wheels on dry pavement at a low speed. They should slide, two fronts together and two rears together and at reasonable pedal pressures. With an empty car, the rears should always slide first on a U.S.-made car.
- Listen, as you make a slow stop, for scraping or grinding noises. These are cause for real concern. A light "wire-brush" noise in brakes, however, is no cause for alarm. It may be characteristic of some linings.
- Stop gently, moving forward and backward in the garage, and listen for repeated clicks. They may be an indication of burred shoes or backing plates.
- Apply the parking brake fully. Is there ample pedal reserve? Release it. Does it release fully or do the wheels drag when you move?

"Be very cautious about any change in normal brake operation," says Leo Mehling, M and M Auto Service, Evansville, Ind. "The smell of brake fluid, or any unusual odor such as the smell of hot lining, is a tip-off to brake trouble." Take care of it fast.

Problems with power brakes. Like other brake components, the power brake is designed to be fail-safe. If the power fails, you still have unassisted braking.



Every brake job should include rebuilding of wheel cylinders and fitting of new seals. Worn, scratched, or pitted bores should be cleaned with a honing tool in an electric drill.

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But you may be surprised at the pedal effort it takes. Some Chrysler, American Motors, and Ford products demand from 160 to an impossible 240 pounds of pedal push if the power-assist fails, says a consumer organization.

You can test the required pedal push on a deserted road by switching off the engine, pumping the pedal lightly to use up stored vacuum, and then trying to stop. You'll find it's a real eye-opener.

One big objection to power brakes is the lack of a standard pedal pressure. Many feel that pedal pressure is too low for good braking control. Power-brake experts counter that you're not supposed to apply full leg pressure to power brakes. They're designed for application by foot pressure only. Your heel should rest on the floorboard.

Modern dual master cylinders protect you against complete loss of brakes if there should be a hydraulic failure. On most cars the front and rear brakes are on separate hydraulic systems. If one fails, the other will give you some braking. What the instruction manuals don't tell you is that stopping with one system not working can be a horrifying experience. It's worst if you're left with rear brakes only.

Be sure your car's hydraulic-system warning light functions when starting the car. Check periodically. If the light ever goes on when applying the brakes, have your hydraulic system looked at as soon as you can. Meanwhile, Detroit is being asked for a light that warns of trouble *before* you step on the brake pedal. One such is already available. If the master-cylinder fluid level drops too low in either reservoir, this new device turns on a warning light.

When Should Brakes Be Relined?

Do your brakes perform as they should? If so, the only way to tell whether they need relining is to pull off a front and a rear brake drum and inspect the linings. Do it every 10,000 miles (once a year, average). Bonded linings worn down to 1/32 inch at their thinnest should be replaced. Riveted linings worn to within 1/64 inch of the rivet heads are through. Always reline *both* fronts or *both* rears at once. Never do one side at a time. It's best to service all four wheels at once.

While the drums are off, look for signs of heat damage. This appears as blue spots around the drum, cooked brake linings, and stretched brake springs. Cooked brake linings are either glazed, cracked, and shiny, or soft and unglazed with the resins burned out. It's common, say service experts. Cooked-through brake linings are done for.

Peel back the rubber boots on the wheel cylinders and look for signs of brake-fluid leakage. Any is too much.

When you handle brake drums and rotors, think of them as eggs. They're that delicate. Never block up your car under the brake drums.

The flat metal clips that have to be re-

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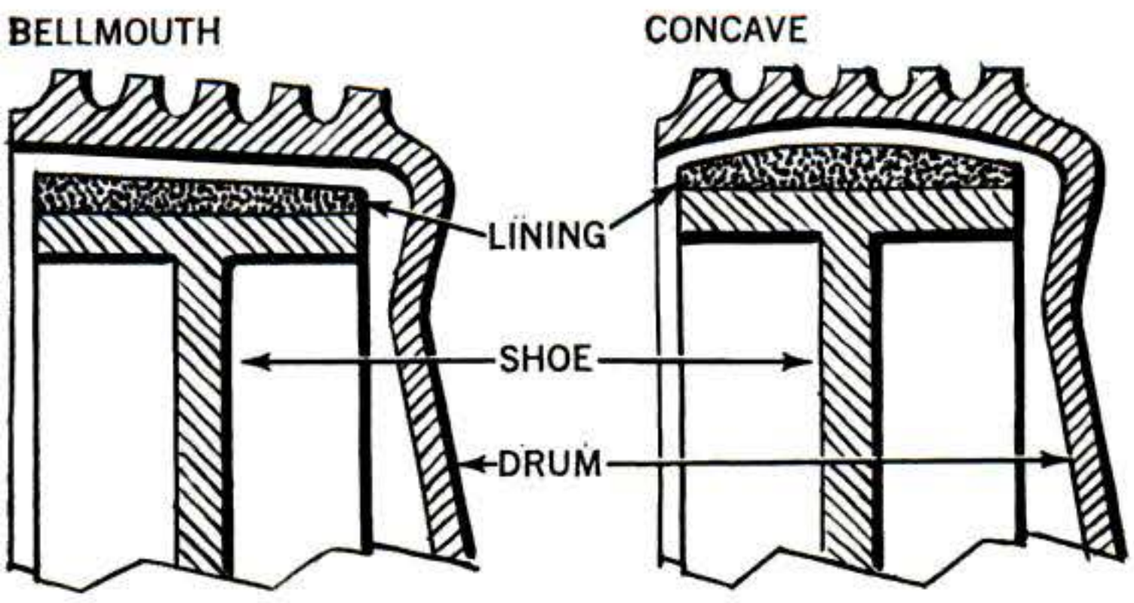

Drums have two typical deformation patterns that can set in any time during their life. Slight bellmouthing or concavity can be cured by turning on a lathe; severe deformation calls for replacement.

When reassembling the brake after relining and overhaul, you can assure quieter operation by smearing a little white lubricant on the backing plate at spots where the side of shoes rub against it.

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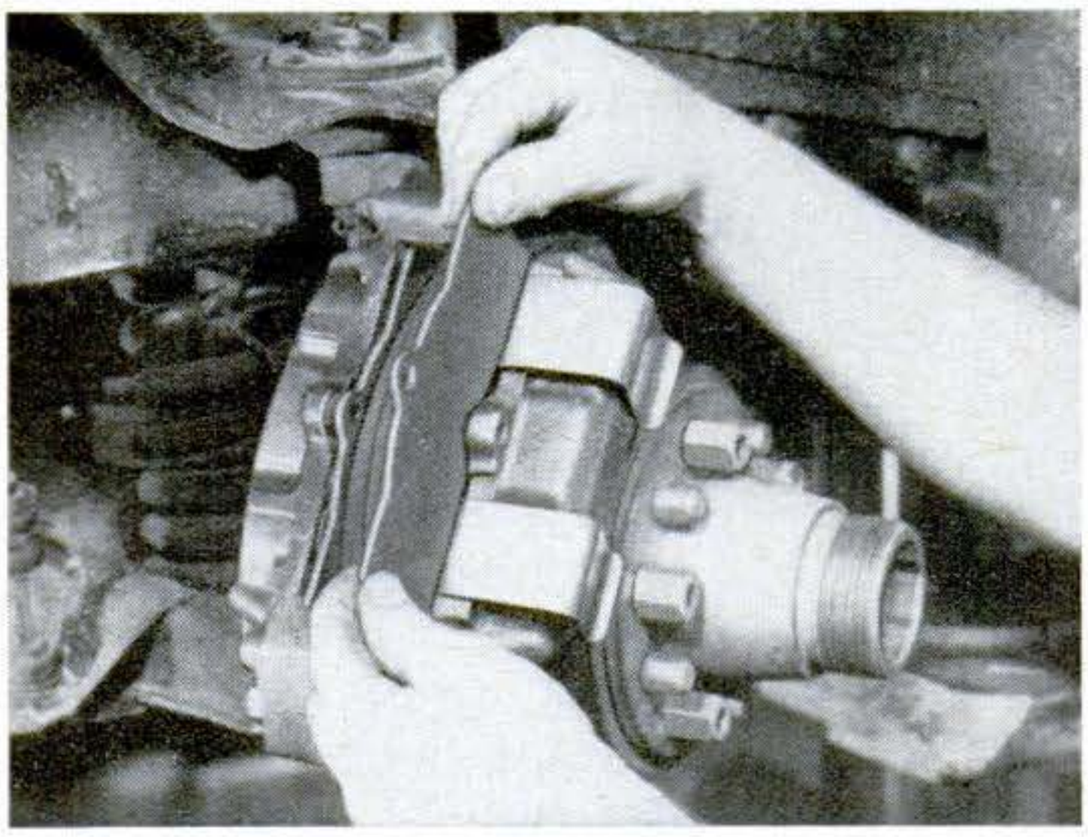
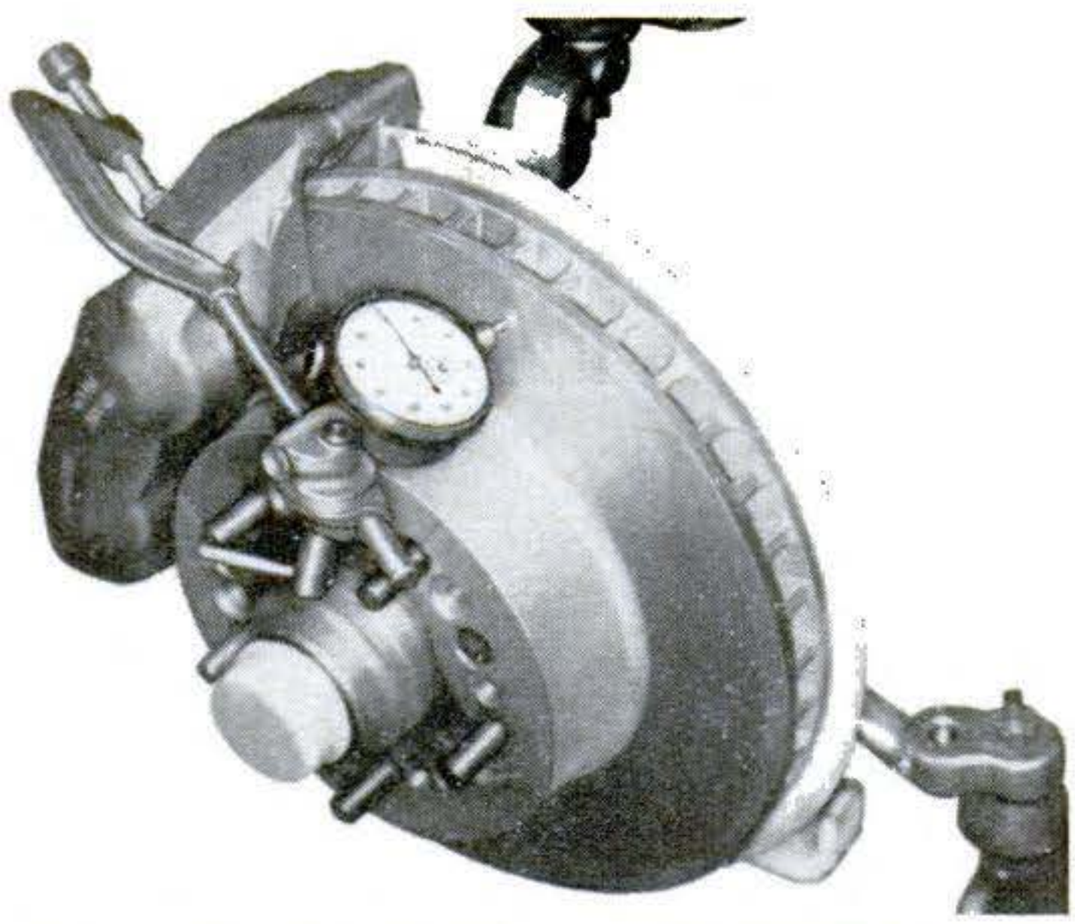
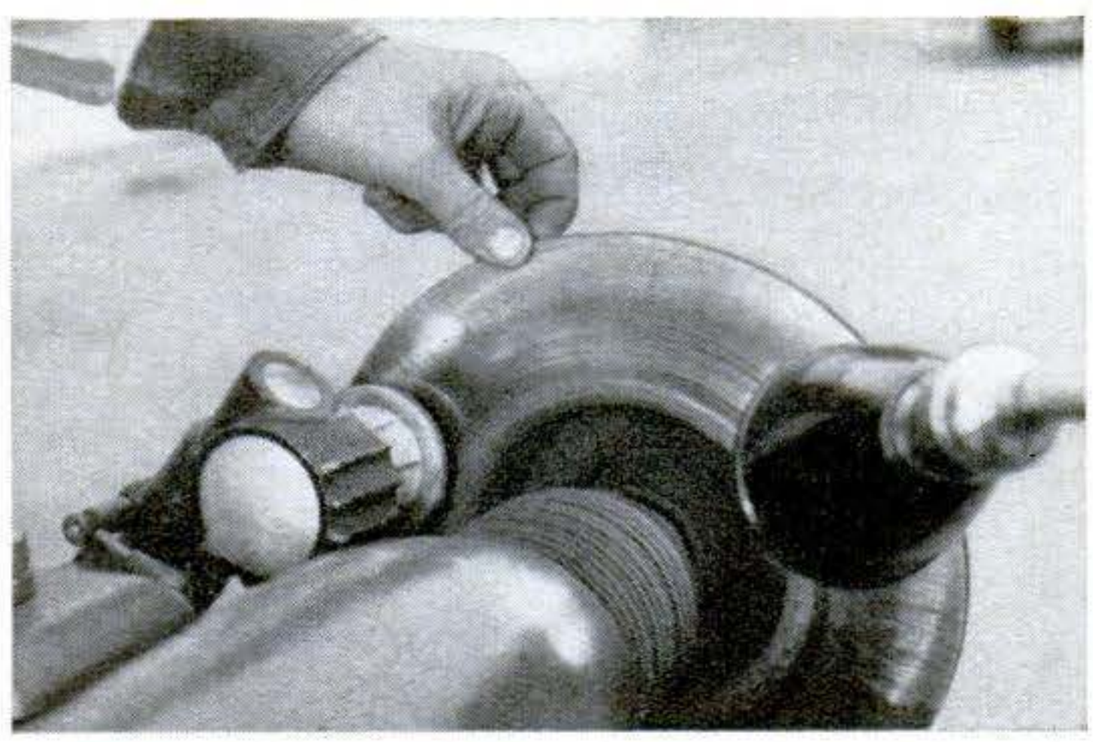


Pad replacement on some disk brakes is quicker and easier than relining drum brakes. Pads slip free when retainers are pulled out; there is no need to remove or dismantle caliper and its hydraulic system.



Major servicing problem with disk brakes is rotor runout and lack of face parallelism. This is critical, because operating clearances are very fine. Best way to check runout is with a dial indicator.



Turning disk-brake rotors requires precision machinery. After turning, rotors need burnishing to give them what brake engineers call a nondirectional finish—done with sanding pad on high-speed grinder.

moved from the wheel studs to get some rear brake drums off are primarily for factory drum retention. They also keep the drum solidly on the shoulders of the lug bolts. A drum that's not properly seated will let the lug bolts loosen and may let the wheel work loose. That's a bad scene, so replace the nuts.

Most dealers will inspect your brakes free. They hope to pick up a reline job. You should get 25,000 to 30,000 miles on a set of linings, but this can vary from 10,000 to 40,000 and more, depending on lining quality, the type of driving you do, and the car itself.

What Linings Should You Use?

The surest way to get poor brakes is to have them relined with poor linings. There's much more to making a brake lining than cranking out some combination of asbestos, resin, and filler. That's what all organic linings—good and bad—are made of. Some contain small wires or metal chips. These are not to be confused with metallic linings, which are a different bag.

Some linings hold well when cool, fade (lose friction) when hot. A lining can also grab harder when hot. Such a lining would make for rough braking. Grabby linings can even self-destruct. Good ones are designed to fade a little but not a lot. Recovery from fade should be fast.

The best advice on buying new brake linings is: 1) Use only original-equipment (OE) linings designed for your car, or 2) use the best-quality premium linings made by a reputable manufacturer.

It's easy to tell you to buy original-equipment brake linings, but hard for you to carry out. Some original-equipment linings are mounted on brake shoes. These usually come in boxes bearing the name of the firm doing the relining, not necessarily the lining maker. Stores selling shoes sometimes can't tell you what brand of lining is on them. They assure you that it's a quality brand. Baloney!

Moreover, some new-car dealers carry factory-furnished "competitive-grade" linings made to meet cheap lining competition. These second-rate materials come

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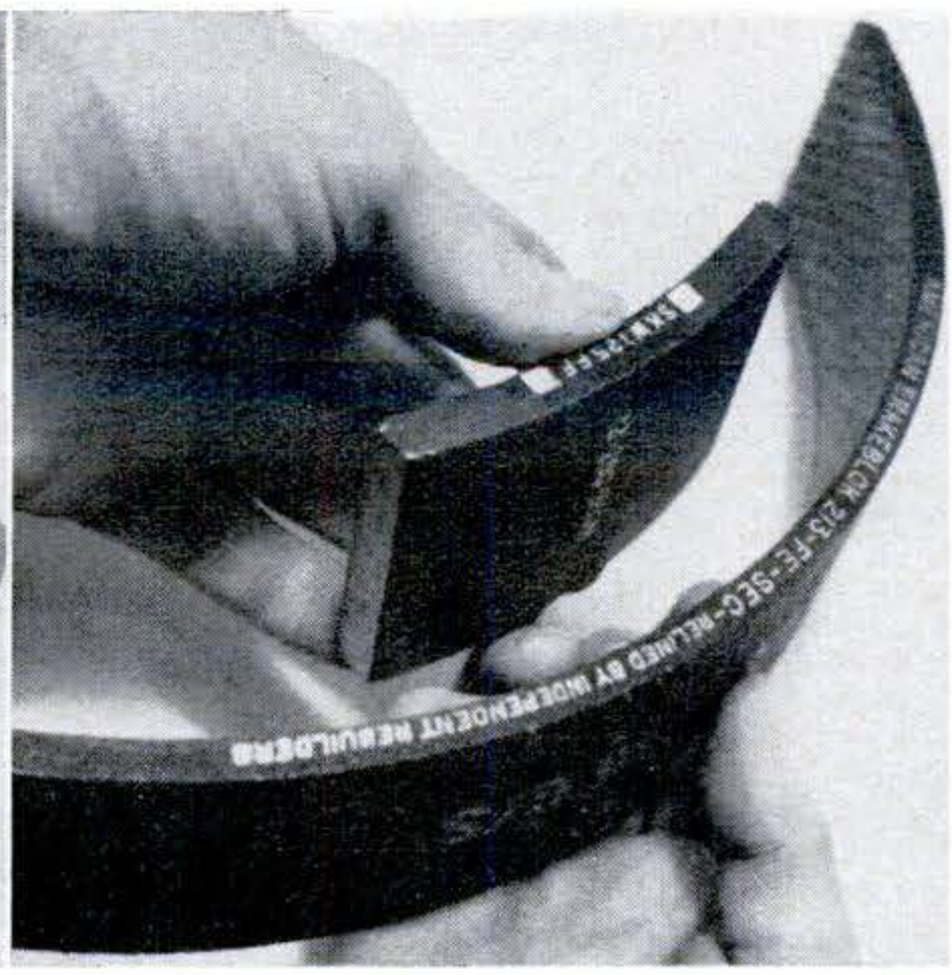
Leading Brake Linings

BRAND*	PREMIUM	STANDARD	LOW-COST
Alden		Premium (45,000 miles)	Standard Brake Lining (30,000 miles)
American Brakeblok	Standard Replacement	ABEX Stopper	
Bendix	Built to meet OE specs	Friction King	
Grey-Rock	Balanced Brakset	Dependable Molded	
Gamble-Skogmo	Varcon Supreme	Varcon Premium	Varcon Standard
Johns-Manville	Four Star		WK
E. J. Korvette		MM Premium	
Maremont Grizzly	Silver Tip	Saftibond	Tru-Guard
Montgomery Ward	Lifetime Supreme	Deluxe	Standard
J. C. Penney	Foremost Premium And Brake Overhaul Kit (50,000 miles)	Foremost Standard	
Porter Thermoid	Custom Bilt	Red Streak	Porto Band
Raybestos	PG	Raymold	
Rayco		R-45 (45,000 miles)	R-20 (20,000 miles)
Sears, Roebuck	S-40 (shop-installed; 40,000 miles)	40, S-25 (shop-installed; 40,000 miles)	25 (25,000 miles)
Spiegel		Premium-grooved	
Wagner	WB	WEB	PAB
Western Auto	Wizard LTG (lifetime guarantee)		Wizard 30 (30,000 miles)
Zayre		Zayre Premium	

*Linings within each column are not necessarily of equal quality.

Disk-brake replacement pads vary in quality, and buying cheap is no economy if you'll need another replacement soon. Many brand-name suppliers offer pads that meet or exceed quality of original pads.



Metallic brake lining (top) is thicker and harder than standard brake lining. This is not a cut-off demonstration piece—metallics come in shorter segments and a row of them is bonded to each brake shoe.

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in boxes with the auto manufacturer's name on them. They seem like original equipment. They're not. What's more, new-car dealers aren't bound to sell factory-supplied brake linings. They can just as well handle a private brand that may not be any good.

Most experts recommend relining with the same type of linings, riveted or bonded, that came with the car when new.

Six states, including New York, require laboratory friction testing of linings. These are nicknamed "New York Tests." The manufacturer must affix brand and friction codes to every lining. For passenger cars, these codes run from D to F, lower to higher friction. The codes come in pairs, like EF. The first letter represents cold friction; the second, hot friction. Whether you live in these states or not, you may well find the codes on your next linings. This doesn't tell how good the linings are.

What, then, is the value of the New York ratings? They have eliminated some poor brake linings from the market. That's all.

How to Choose a Lining

Aftermarket brake linings come in three principal grades: low-cost, standard, and premium. They're not always called by these names. Never use low-cost linings, even those made by a reputable manufacturer. Often they give you only single-friction materials. Most cars were designed to operate with double-friction linings, one for the primary shoe and a harder one for the secondary shoe. With single-friction linings, the lining on the secondary shoes will wear out first.

If standard braking suits you, you can use standard linings. Figure on spending about $15 for a set of eight relined brake shoes. Premium linings will cost around $25 a set. Trade-in of the old shoes is included. The premium linings of every firm are not necessarily equal in quality. You can't be influenced by price alone. Some carry a huge markup.

As to brand of replacement lining, you can only go by reputation. I asked every expert I interviewed, off the record, what he thought were the best aftermarket linings. Some refused to answer. The others were in close agreement on these five brands (not in any order): Raybestos, Grey-Rock, Bendix, Wagner, and American Brakeblok. These are major brands of brake linings for OE and the aftermarket. Their listing may reflect bigness as well as quality of the product.

Obviously other firms produce good brake linings. For instance, Cyclo-Weld and Inland linings are made for new Chrysler and many General Motors cars by

The Right Drum-Brake Job

ITEM	MINIMUM	BEST JOB
Drums	Inspect, turn if needed	Turn all
Linings	Original equipment or reputable premium lining	Original equipment or reputable premium lining
Shoes	Fitted to drum	Oversize linings fixed-anchor-ground to fit drum
Hydraulic fluid	Flush new fluid through system	Flush new fluid through system
Wheel cylinders	Rebuild or replace all	Rebuild or replace all
Master cylinder	Check for leaks. Rebuild or replace if needed	Rebuild or replace
Retracting, hold-down springs	Inspect, replace if damaged	All new
Backing plate	Clean and lubricate	Clean and lubricate
Front-wheel bearings	Repack	Repack
Grease seals	Replace front, inspect rear for leaking	Replace front, inspect rear for leaking
Front-wheel cotter pins	Install new	Install new
Brake lines, hoses	Inspect, replace if aged, cracked, damaged, or leaking	Inspect, replace if aged, cracked, damaged, or leaking

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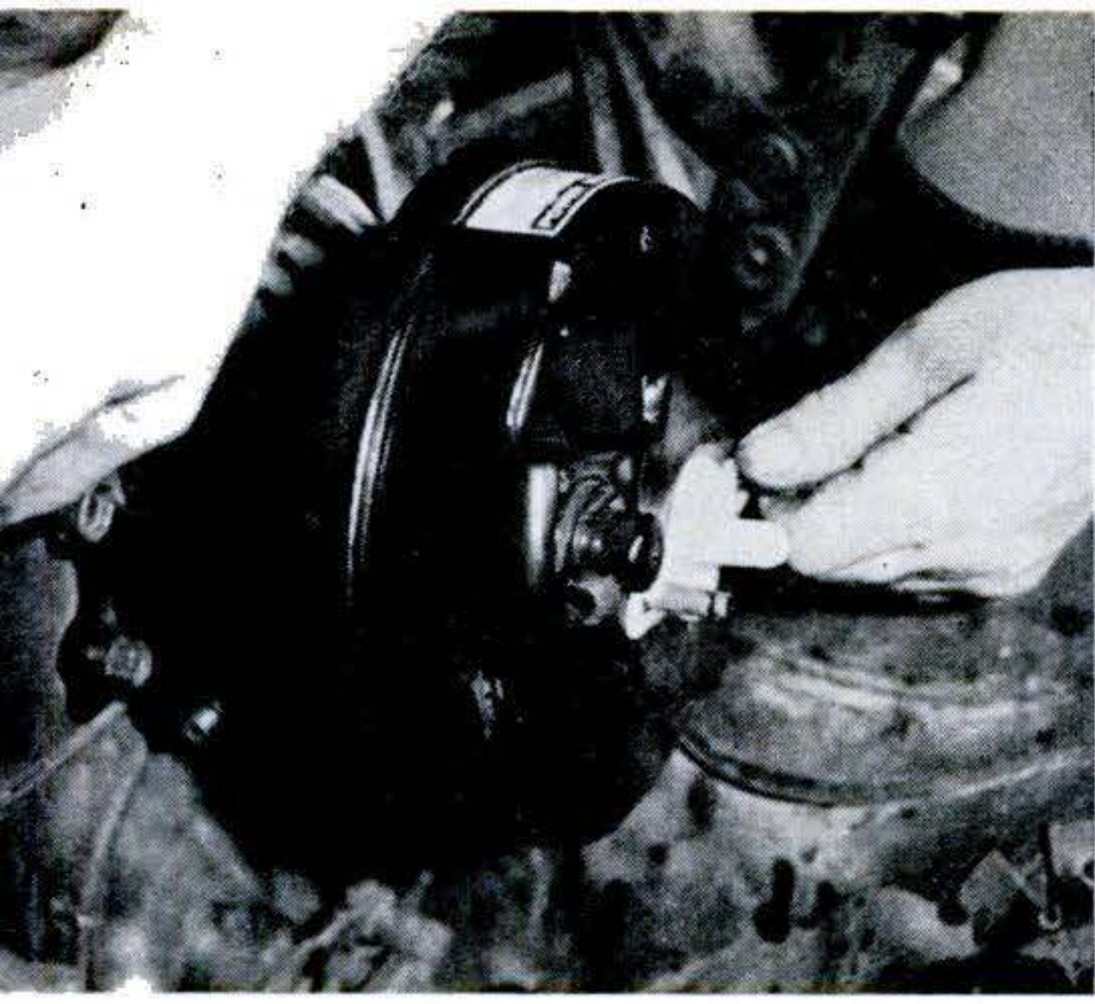
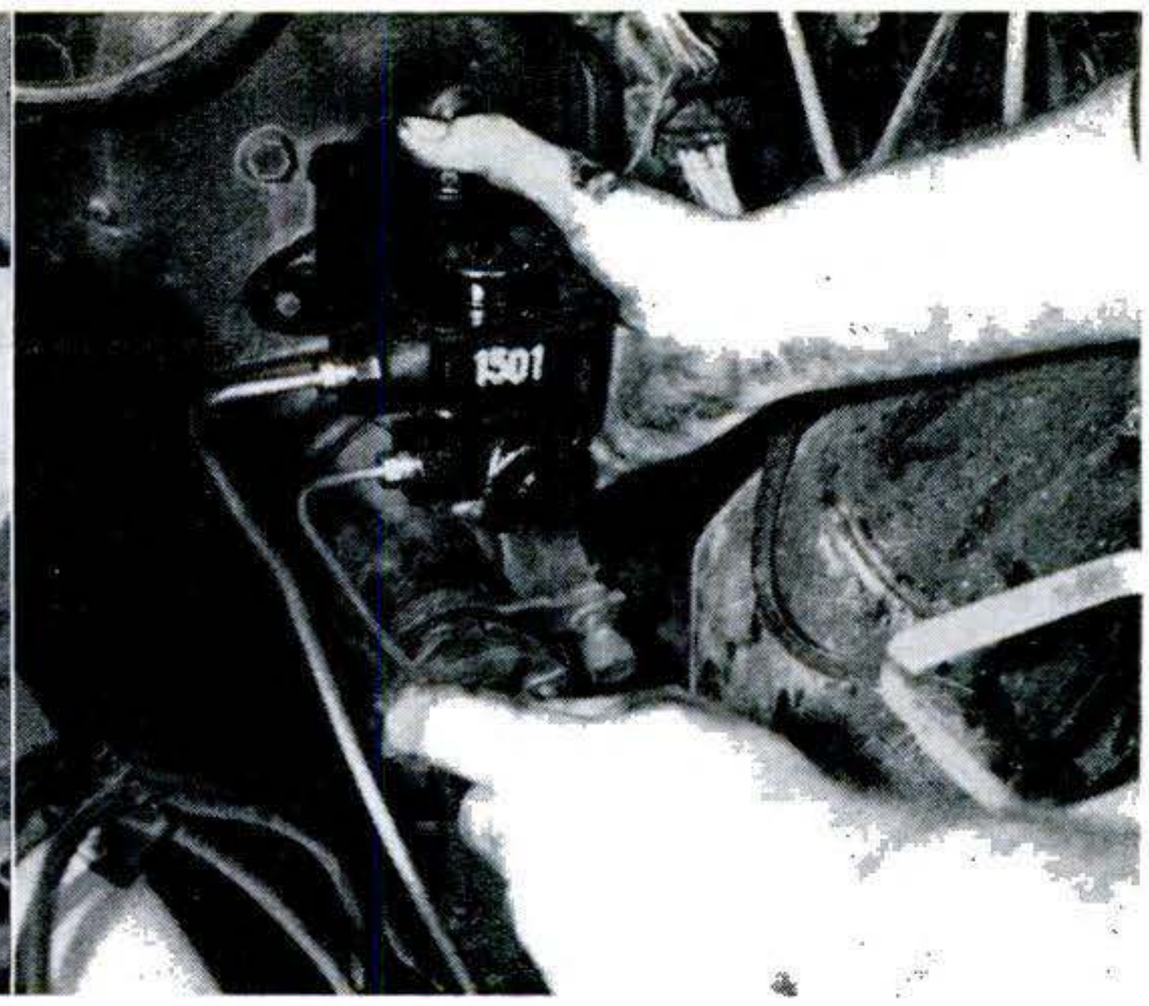


Want power brakes? Bendix makes kits for most U.S. cars. Power-booster unit bolts direct to firewall, and the old master cylinder mounts in front. Installation is a snap, needing no change in brake lines.



With an older car without fail-safe dual-circuit hydraulic system, you can install a Bendix conversion unit in an afternoon. New master cylinder replaces old single-piston one, with or without power brakes.

company-owned subsidiaries. These linings should be good replacement buys as well.

"When you buy quality brake linings, you're buying quality control, too," one expert told me. "One is as important as the other."

Metallic linings. You've probably heard a great deal about metallic brake linings. Will they do your car any good? Metallic linings are made of sintered iron or a mixture of powdered iron and graphite. They are used chiefly because they can take terrific punishment without fading or burning up. In fact, metallics work best when hot. That's why you might not like them for your car. They don't hold well *until* they're warmed up. The first few stops in the morning may scare you. But there's a definite need for them.

Metallic linings such as the higher-friction VelveTouch-Metalik are used mostly on police cars, taxis, and other heavy-service vehicles. Severe service is their middle name. You should consider metallics only if premium linings can't handle your braking requirements. Trailering in mountain country or pulling a heavy boat or house might qualify you. Hot-rodding, definitely.

Squeak and rapid drum wear are the usual bit with metallics. Some require special drum treatment. Expect a hard pedal unless your car has power brakes. Cost of eight lined brake shoes will run to about $40.

How Much Should a Brake Job Cost?

Brake jobs advertised at $9.95 and $19.95 can be murder. No shop can do a decent, safe brake job for those prices. A proper job can cost $60 to $70. The cheap prices are usually come-ons. The extras pile up to $60 or so. Shops that neglect the extras completely are scorned by reputable mechanics as "shoe hangers." They're setting you up for real trouble later on.

Brake experts don't agree completely on just what items should be included in a brake relining.

"Do it right. This is the only way you can be sure of the job," says Walt Alley of AMMCO Tools, manufacturer of brake-service equipment. "For instance, I've seen too many wheel cylinders fail soon after a brake job. Wheel cylinders should be rebuilt." Many others, especially those who service brakes, echo this.

On the other hand, brake engineers with some of the auto makers told me that wheel and master cylinders are designed to last the life of the car.

Brake drums may or may not need turning. Many recommend it on all jobs. Dale Hays of Dale's Service, Inc., Mason City, Iowa, was one of these. "We've

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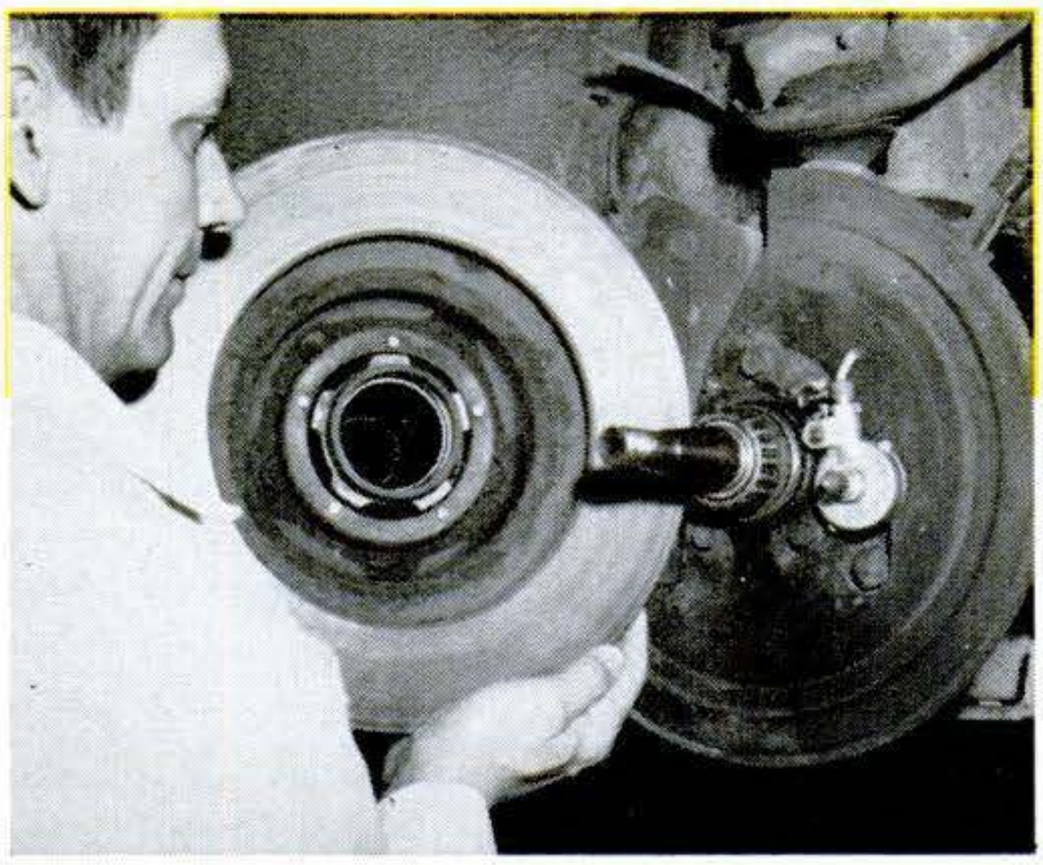
Test car equipped with Bendix's experimental four-wheel antilocking brake system (foreground) came to a stop from 70 m.p.h. without skidding in a simulated panic stop. System releases line pressure every time wheel threatens to lock, reapplies pressure as wheel speed matches road speed.



Wheel-speed sensor for Bendix antilocking brake system is geared to a pinion on wheel hub. Sensor feeds information to a computer that modulates line pressure to the wheel in rapid cycles.

found that all drums are off enough that it gives us a better brake job if we turn them all."

W. C. Wilder, Wilder Motor Co., Nashville, Tenn., took the opposite view. "We turn drums only as needed. Drum condition determines it. We find that most late-model drums are severely heat-checked." Some shops turn all front drums, the rears only when necessary.

If you have a brake job done, choose a shop you trust. Pick one known for service. A guarantee helps, too. Ask the manager what kind of brake linings he uses and what items of service he performs during a brake job. Request an even better job if you like. After all, it's *your* money and *your* life.

Big-chain auto service is mostly reliable. Most have learned through experience that a thorough job makes satisfied customers and builds a good reputation. Sears, Ward, Penney, Mobil, Firestone, Goodyear, B.F. Goodrich, and Midas all are known for quality brake work.

Sears has 500 brake shops nationwide. Each shop averages four or five brake jobs a day. Their policies are representative of big-chain service. Both standard and premium linings are available. Premium linings cost about $50 installed and the job is guaranteed for 40,000 miles. Brake lining .040 inch oversize is put in and fixed-anchor-ground to fit each turned-out drum.

Sears' standard lining is .025 inch oversize, installed for about $40. Guarantee is for 25,000 miles.

The IGOA shops reported prices for complete brake jobs from $40 to $85. All used name-brand linings. Procedures varied from "minimum" to "best job."

Getting qualified mechanics for brake service has become such a problem that at least one lining manufacturer, Raybestos-Manhattan, is helping in a training program aimed at high-school students and others. E. H. Moss, president of training with Pros, Inc., developed the course based on plastic mockups of actual brakes. Upon completion of the 15-hour classroom course, a student is ready to work on the car itself.

Raybestos is marketing the program to the auto-service industry. McGraw-Hill is marketing it to high schools throughout the United States.

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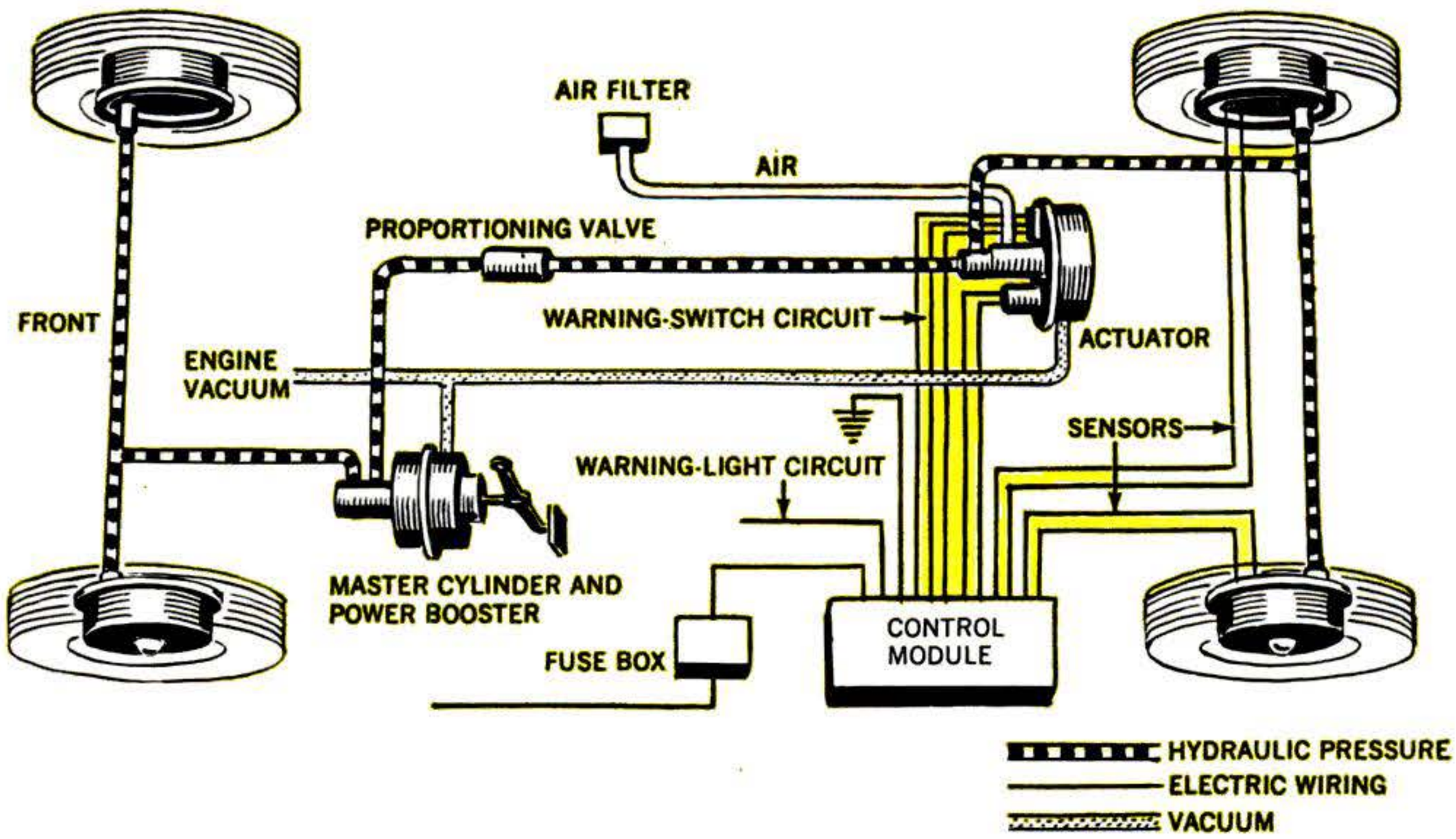

Should You Reline Your Own Brakes?

I asked this of just about everyone I talked to. "You can, if you want to," the answers came. When you look at a self-adjusting brake, you may be glad to back out of do-it-yourself relining.

To do your own brake job you'll need a manual covering your type of brake. Also pick up a pair of brake-spring pliers or a brake tool. These help you get the shoe-retracting springs off and on without overstretching them. Never grab a brake spring with a pair of side-cutting pliers. They'll nick it. Later it may fail.

No brake job is complete without a thorough inspection of all hydraulic-system parts. Brake hoses are too often neglected. "Most people think they're intended to last the life of the car." commented Bob Kolena of Brake Parts Co., a large Midwest supplier of brake components. "Not so. Road salt, road oils, and ozone in the air all take their toll on brake hoses. These can cut the life of a brake hose to as short as a few years."

Inspect brake hoses for tiny rubber cracks, chafing, torn covering at the ferrules, and damage caused by flying stones. Any of these are cause for replacement. New hoses should meet federal specification 106. Check them for good crimp in the end fittings and cuts. "40R1" should be stamped on the hose, signifying it meets that SAE specification.

Wheel cylinders most often are rebuilt. It's cheaper than buying new ones. New rubber parts and springs are installed from a rebuilding kit. If the cylinder is worn, scored, glazed, or pitted, it will have to be honed. Some wheel cylinders can be honed on the car. Others must be removed.

Flushing the hydraulic system of old fluid is important every time you reline. Brake fluid sops up moisture from the air. Even the newer sealed hydraulic systems don't keep water out. It's amazingly common to find other contaminants than water in hydraulic systems. Careless service-station mechanics are noted for pouring things like gasoline, kerosene, antifreeze, and motor oil into brake systems. Some of these make rubber parts swell. If you find any signs of swelling rubber, replace the brake hoses along with all the other rubber parts.

For a car with drum brakes, do your flushing with the new "super-heavy-duty" brake fluid meeting SAE J1703. Amber in color, it won't boil below 374 degrees when free of moisture. For a car with

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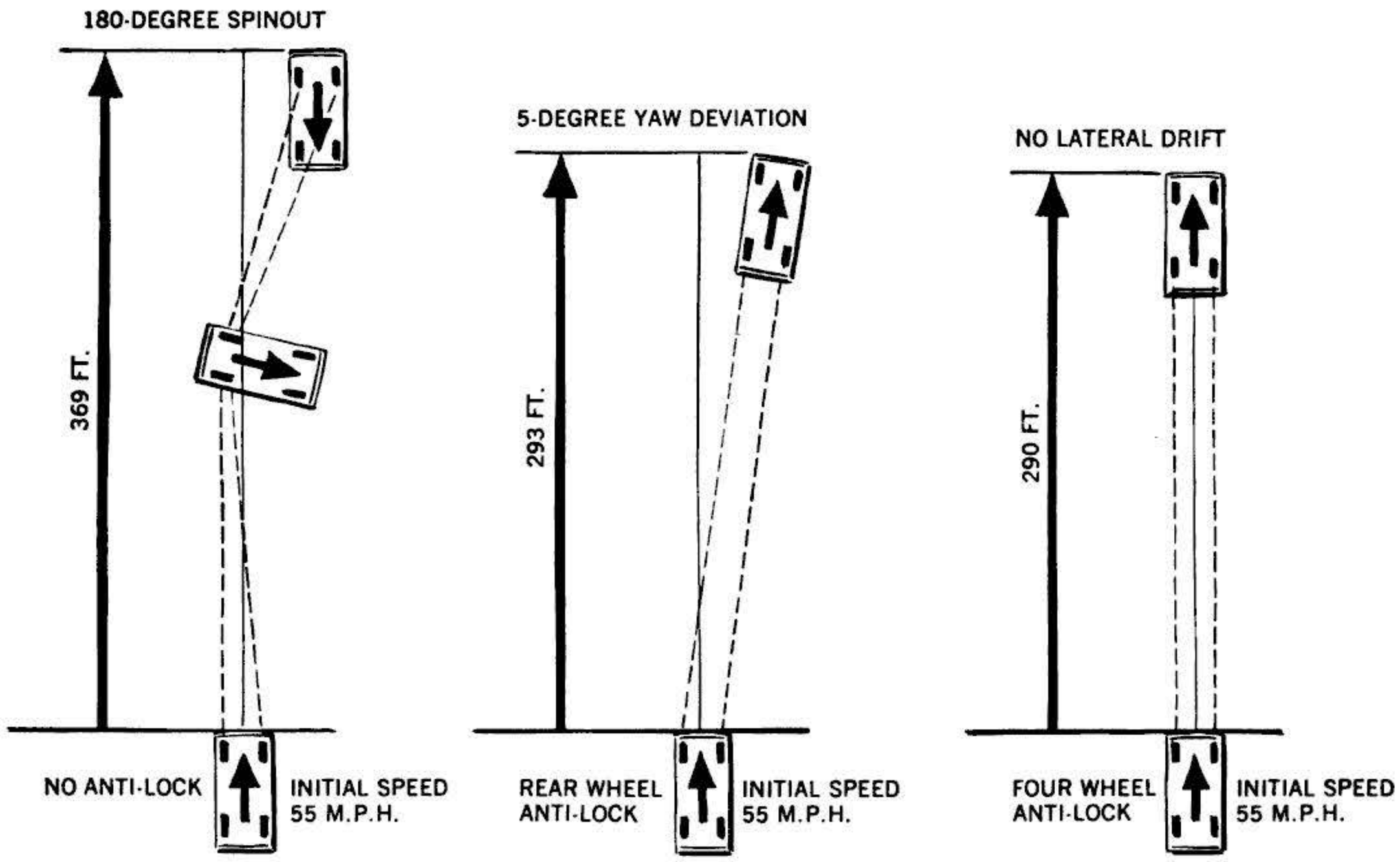

Tests made by GM show improvements in stopping distance and braking stability with four-wheel anti-lock system, compared with a simplified version of same system operating on rear wheels only. Sketch at left shows typical vehicle behavior (assuming an unskilled driver) in a panic stop on slippery surface.

disk brakes, use the blue-green 550-degree-boiling-point disk-brake fluid or auto manufacturer's recommended fluid. The "550" fluid may be used in drum-brake cars, too, if the master cylinder has a rubber diaphragm under the cover.

Never use anything but disk fluid in a car with disk brakes. To prevent mixups, Ford and Chrysler put disk fluid in all cars on the assembly line.

A close shoe fit with the drum is important to the proper operation of your self-adjusting brakes. A sloppy fit can throw the adjusters out of whack. What's worse, ineffective braking, overheating, increased lining wear, and all kinds of brake noises can plague you if shoe-fitting isn't done.

In an old fitting method, a set of linings was shimmed out away from the metal brake shoes to make up for material removed from the drum during turning. More sophisticated fitting is now needed. If the drum has been turned out a great deal, the shoes will have too small a curve. Then thicker linings ground in a shoe-arcing machine are needed. This is done best with the shoes supported on an anchor pin, just as they will be in the brake assembly. This is called fixed-anchor grinding. The anchor pin on the machine adjusts to match exactly the location of each brake's fixed anchor pin.

With a do-it-yourself brake job, you can take advantage of fixed-anchor grinding. Simply tell your machine shop to fixed-anchor-grind your newly lined brake shoes. Don't expect a higher brake pedal after relining a car with self-adjusting brakes unless the shoes are fixed-anchor-ground.

Never try to clean and re-use grease- or fluid-soaked brake linings. They're finished. You must put new linings on both sides of the axle, not just the soaked side. Braking force otherwise may not match, side to side, and you'll have brakes that pull to one side. Dangerous.

Drum brakes vs. disk brakes. The big question being batted around today is whether drum or disk brakes are better. In "Great Brake Debate: Disks or Drums?" [PS, Aug. '66], both sides of the question were argued. Briefly, the argument stacks up this way:

For drum brakes: More economical to produce, easily made self-energizing, understood by more of those who service them, easily operated mechanically for

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parking, and operable on lower hydraulic-line pressures.

For disk brakes: Negligible fade, not affected by water, don't swerve car when applied, excellent brake control, equal braking at all speeds, and in some cases easier to reline.

"The truth is that the best brakes your car can have are disks, front and rear," says Rene Vansteenkiste of Budd. With disks you have a surer feel of the brakes at every speed. Since disks are hard to lock up unless you're trying, steering control throughout hard stops is maintained. Disk brakes can take lots of punishment. Heat, too. Rotors have been red-hot at Sebring, but the race cars were still braking well on every turn.

At present, disk brakes are offered as standard or optional on the fronts of nearly all U.S. cars. They're coupled with conventional drum brakes on the rear. Because the front brakes do most of the work—sometimes as much as 75 percent—this is a fair compromise. It provides disk brakes where they're needed most and lower-cost drum brakes where disks' fade resistance isn't so important. Most new disk brakes use the "second-generation" single-piston floating caliper. The Corvette comes with four-wheel disks. They are optional on the Camaro.

PS Extra: BRAKES

Anyone who wants the best available brakes should order the disk option. All 1968 and '69 Fords with power brakes have disk brakes. Many '69s of other makes have the same program.

Four-wheel disks will be common when the engineers figure a practical way to adapt heavy-duty parking brakes to disks. Present tough industry and federal safety standards for parking brakes demand friction devices. Simple pawl- or cog-type parking brakes are ruled out. Higher-performance four-wheel disk brakes are temporarily stalled in the name of parking-brake safety. Ironic.

Antiskid braking. The newest development is the antiskid braking system. The auto industry was working on it when the federal government first got interested in automotive safety. Since then antiskid has been on a crash program. Ford is first to come out with it. Built by Kelsey-Hayes, it's optional on the rear wheels of the 1969 Continental Mark III. Cost is about $150.

Actually the term antiskid is a misnomer. The devices will not control sideways skidding. The industry is searching for a better term. Some call it skid-

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How original-equipment brakes are tested before they reach you

The auto, brake, and lining manufacturers do considerable testing of brakes. These include laboratory tests and car tests.

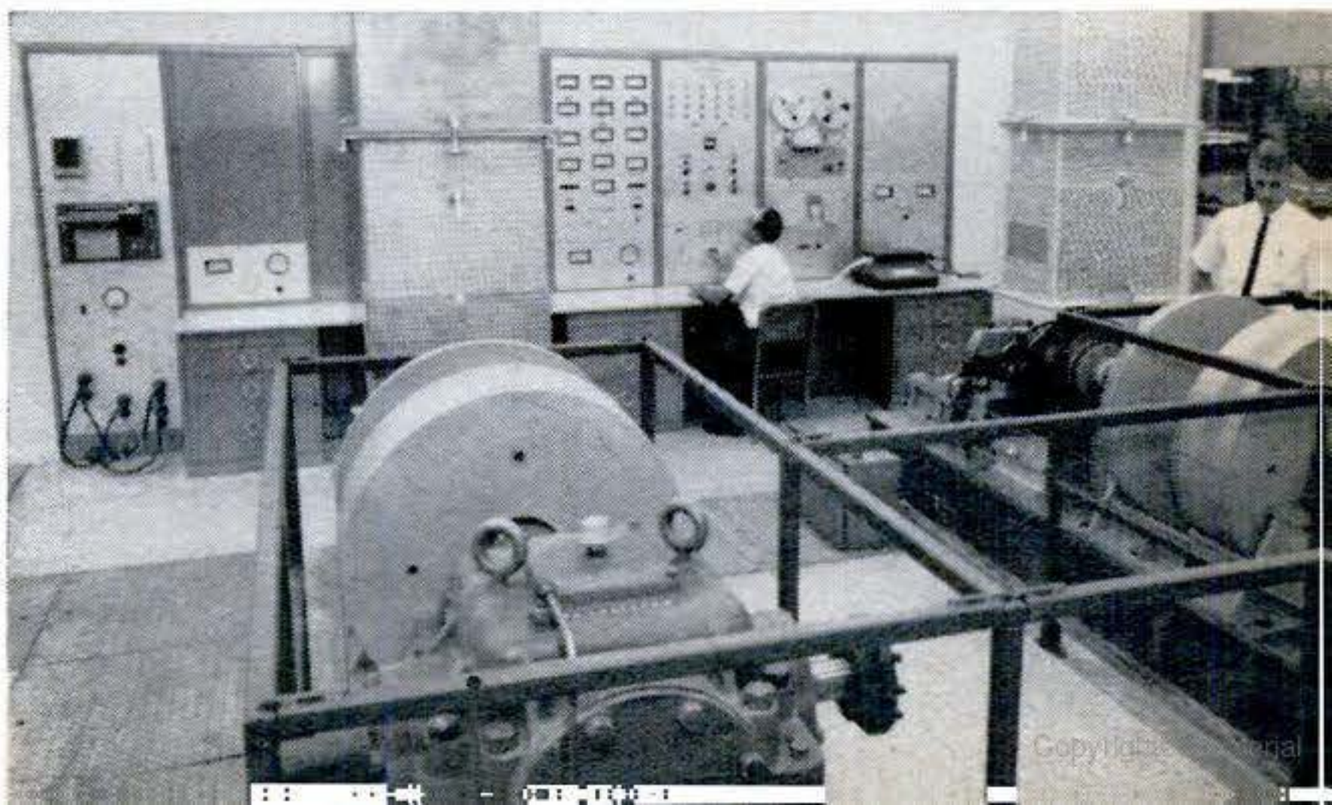
For your safety, all brake parts are designed to yield when overloaded rather than break. This is ensured by testing first in the lab, then on cars. Bendix has a huge brake laboratory at South Bend, Ind. A dynamometer there will test two brakes at once.

Testing can be computer-programed to simulate actual road conditions. The brake is covered by a wheel and placed in a moving air stream that varies with wheel speed. Weights are set spinning, then braked to a stop. The amount of weight is adjustable for different cars and loads. Speed, pedal effort, and frequency of application are adjustable.

Ford has a similarly equipped brake laboratory that can test four brakes at once. Raybestos has many brake dynamometers capable of handling full-size assemblies, and a 26-vehicle road-test fleet for evaluating new brake linings.

After a brake part has been proved in the lab, it goes out for further testing. Bendix bought the old Studebaker Proving Ground for this purpose. A portion of the test track serves as a 1,000-foot skid pad with a special surface that can be made slick as wet ice. Flat and mountainous courses are used by the auto makers to prove new brake linings and designs.

Brake parts are designed to take normal use and a reasonable amount of abuse. Testing makes sure, for your safety.



control braking; some, adaptive braking; still others, anti-lock braking. Ford, GM, Bendix, TRW are developing systems.

Stopping distance with a four-wheel Bendix antiskid unit was cut between five and 15 percent on dry pavement. That's about half a car length. Recent extensive GM tests show wet-pavement stopping-distance improvements of between two and 23 percent. Slippery-pavement reductions of 30 to 40 percent are possible, according to Bendix experiments. Tire condition has a lot to do with effectiveness, of course.

Stability, not shorter stopping distance, is the big benefit of antiskid. Two-wheel antiskid braking can help you cope with emergency braking on soft shoulders, with worn tires, and with blowouts. Four-wheel systems are another step in improving directional control. Four-wheel antiskid braking will help you when braking on curves, regaining control after drifting onto a soft shoulder, braking on icy roads with cross slopes, and steering around obstructions or changing lanes while braking.

What's in the future? The weaknesses of brakes today point toward future developments. A major weakness is brake lines and hoses. The auto makers know this and are working on it.

Roger Goyette of Sparky's Service Center, New Bedford, Mass., puts it this way: "A killer is steel brake tubing that rusts and gives way with no warning."

Stainless steel would be used but it can't be flared. Too hard. Copper, on the other hand, becomes brittle when vibrated and can burst without notice. Racing cars may have the answer. They use flexible neoprene brake hoses sometimes covered with woven stainless steel.

Whatever the future brings, good brakes are like good insurance. As Sears, Roebuck's Bob Lawyer puts it:

"We sell $50 worth of living insurance in the form of a brake job. Unlike other insurance, the customer doesn't have to wait for an accident to collect. He reaps the benefits every minute he's driving."

How vehicle testing finds bad brakes and prevents accidents

In January, all states became involved in vehicle testing. Federal law will cut off 10 percent of the highway funds for any that aren't. Brakes are a vital part of every test program being developed.

Cincinnati has been testing brakes ever since 1940. During 1967, 267,000 vehicles went through the test lane. Thirty percent were rejected for bad brakes. Brakes were second only to lights in number of failures.

The city's original Bendix brake testers are still in use. A car's front wheels drop onto a pair of rotating drums, and the brakes are applied by a city employee. Pedal pressure is increased until the brakes produce one-quarter of the car's weight per axle in decelerating torque. This averages about 500 foot-pounds per wheel. Measurements are made by torque arms and scales. Readings appear on two dials placed where both owner and driver can see them. The parking brake must pass the same test.

Brake-pedal height also is checked. Minimum is 1½ inches.

Disk brakes come through best of all, according to lane manager Ed Grant. Rejection of these is rare.

The owner of a rejected car has 30 days to get his car repaired and bring it back for a retest. If a car's brakes are considered unsafe, it is tagged "unroadworthy," pulled off to one side, and parked. The owner must have it towed away for repair.

"It's almost impossible to tell how much good vehicle testing has done," says Grant, "but with all the dangerous cars we've kept off the streets, we must have prevented some accidents."

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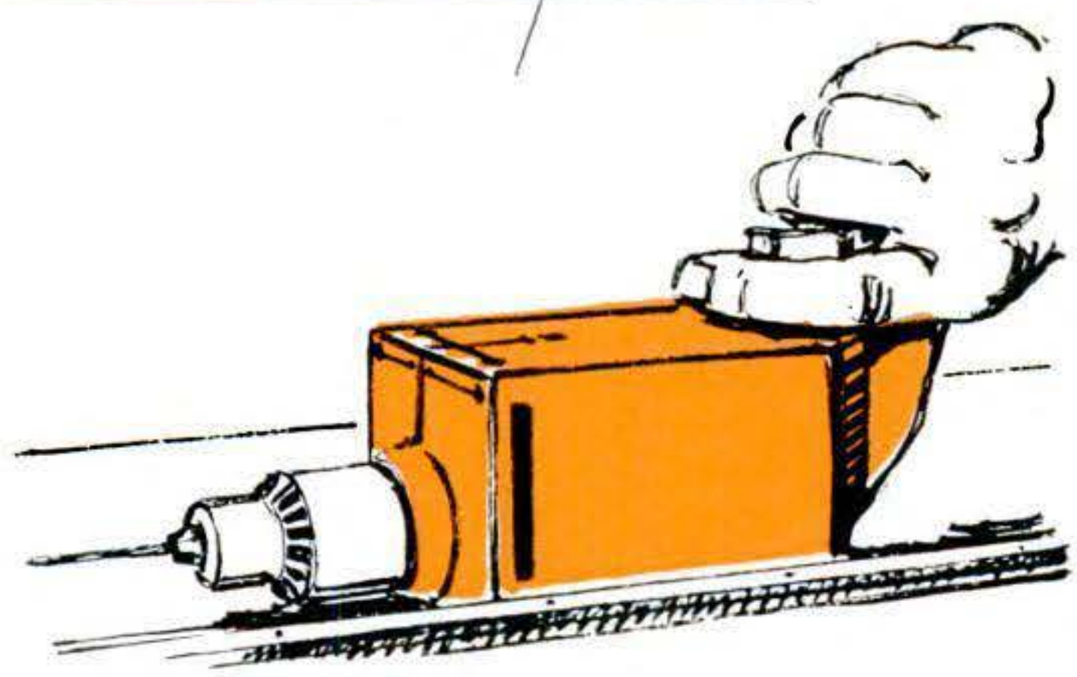
I'd like to see them make..."

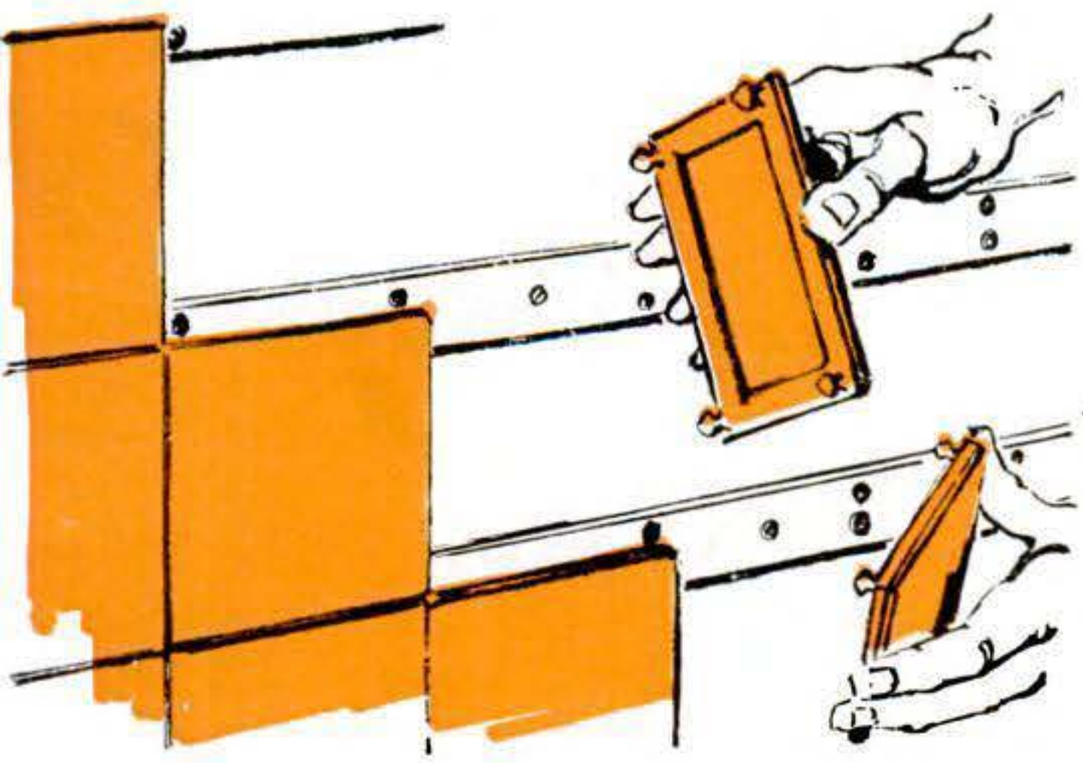
DRAWINGS BY DANA RASMUSSEN

Light-up boards at ends of aisles at big parking lots. A light would signal an empty slot and eliminate endless and useless traffic. *–Kingsley West, NYC.*

A muscle-saving attachment for electric mixers. Special attachment pads would scour pots or polish brass, copper, and silver.–*M. B. Jarrell, Barrett, W. Va.*



Square-cased drills to simplify precise drilling. With case edge and spindle centerline exactly parallel, an angle iron could serve as a positioner.–*D. R. Feeley, Azusa, Calif.*



Inexpensive snap-on tiles you'd fasten to a special furring strip. Changing the wall color that way would be lots easier than using a brush.–*Dave Fabian, Galion, Ohio.*

A flat ledge around the bottom of trash cans. To dump stuff in them, you could put a foot on the ledge and remove the lid with one hand.–*C. E. Ericsson, Trumbull, Conn.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 10017. Write your name and address clearly. Contributions cannot be acknowledged or returned.

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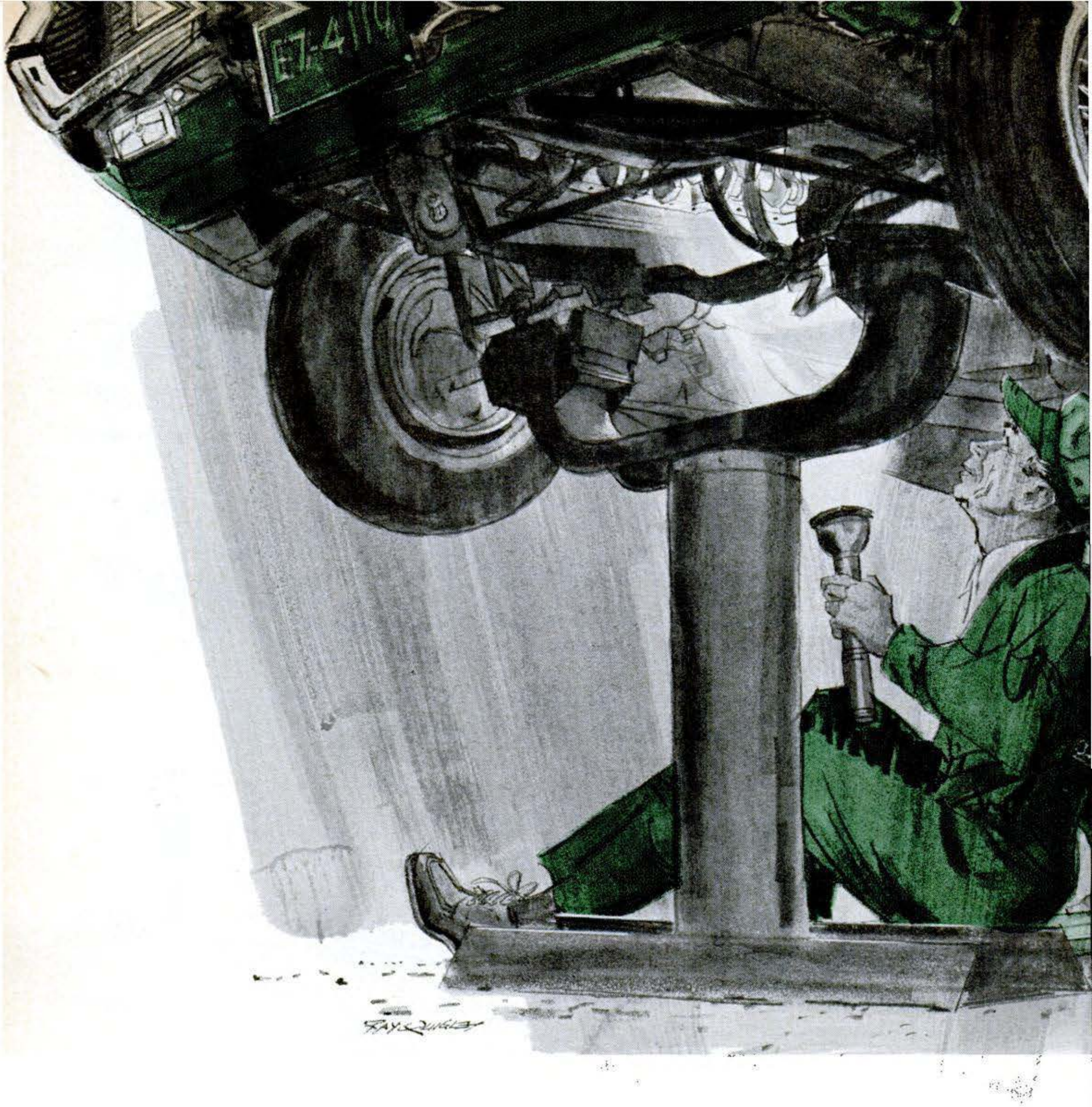

Gus Takes the Worry Out of a Warranty

By MARTIN BUNN

"Here comes No. 17!" called one of the three young men seated at a table set up in front of the Model Garage. A small group of spectators nearby watched as a 1969 Cougar hardtop braked to a quick stop. Its young driver slid out and trotted over to the table.

"Car 17 checking in," he said, and added anxiously: "Right on time, I hope."

The middle man of the trio glanced at a bank of timers. "You're 73.2 seconds late," he said sternly, and then added with a grin, "but that's the best time so far this morning."

Gus Wilson, owner of the Model Garage, watched the check-in ceremony through the office window.

"To tell the truth," said Stan Hicks

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Sliding under the lifted car on a creeper, Gus aimed the beam of his flashlight at the back end of the massive crankshaft.

ILLUSTRATION BY RAY QUIGLEY

Carl Williams' new car had known only tender loving care. Why should it burn a quart of oil every 200 miles?

his assistant, "I prefer the black-and-white checkered flags and roaring crowds. Those timers and tally sheets make it look more like a rocket-launching than a road race."

"Uh-uh, Stan," said Gus. "It's a *rally*, not a race. A rally is a test of driving precision, not fast driving."

"I know all about it," said Stan, holding up a booklet. "I quote the Centerville Rally Club's official publication: *"'Each car must cover a complex course over public roads, at legal speeds, following a precise timetable. For this reason, each car carries a navigator as well as a driver. The aim is to arrive at the check points on schedule . . .'"*

One of the timekeepers poked his head through the office door. "Two cars still to come, Mr. Wilson," he called. "Then we'll get out of your way. Our club sure appreciates the use of your place as final check-in point. I hope we haven't interfered any with business."

"Not much business on Sunday morning," answered Gus. He looked up at the sky. "Especially when it's going to rain."

"You're about to get some business from Carl Williams—that's me," a youthful voice said glumly. It belonged to the Cougar's driver.

"Gas? Oil? Or both?" asked Stan.

"Plenty of both—and I'd like you to take the engine apart."

The young man smiled at Stan's and Gus's startled expressions. "This car burns oil like crazy, almost a quart every 200 miles. Maybe you can tell me why."

Gus shook his head. "You've got a new car—oil consumption is a warranty problem. Your dealer should handle the repairs, and the diagnosis."

"That's my *real* problem," Carl said. "My dealer claims that the warranty doesn't cover the car since—uh—since I go in for rally driving."

"That's odd," said Gus. "Racing a new car does void the warranty. But since rallies aren't really races . . ."

Carl sighed. "My dealer says they are races—especially the long-distance kind I like to enter. He warned me about the warranty question when I first painted the rally stripe on the body—that was 10 rallies ago."

Gus chewed on his pipe stem thoughtfully. "Still, though, if the oil consumption were caused by a mechanical flaw," he began, "rather than wear and tear . . ."

"Right!" said Carl. "If you could prove that, then my dealer would have to honor the warranty."

"Hold everything . . ." said Gus.

"Mr. Wilson," Carl interrupted, "I've driven the car hard for the past few

Continued

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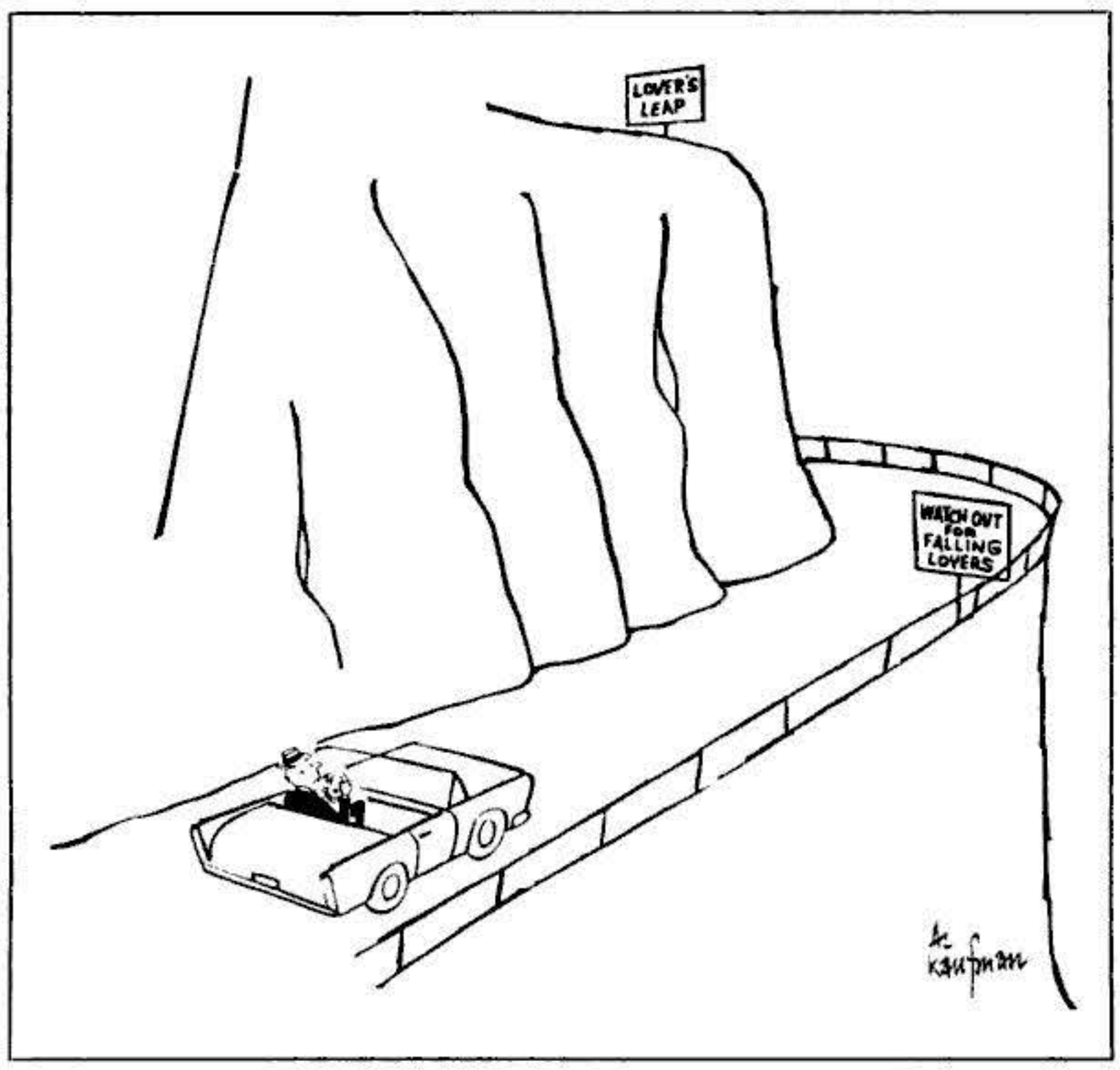
[illegible], I know I haven't abused the engine. You'll see when you examine it. I'll drive the car onto the lift."

"Whoa!" shouted Gus, with absolutely no effect. Carl raced from the office.

Stan chuckled. "And you were going to spend today getting your gear in shape for the fishing season." He looked out at the rain now pelting down, then at the Cougar backing toward the open door. "I guess I'll brave the elements and get us all sandwiches and coffee for lunch."

The Cougar sat on the lowered lift



blades, its hood raised, its big V-8 idling smoothly. Gus reached into the engine compartment and pushed the accelerator linkage for a moment.

When the roar died down, Gus turned to Carl. "If the engine was burning a quart of oil every 200 miles, the exhaust would be full of blue smoke. As you can see, the exhaust is clear--even at high r.p.m. More likely, the problem is an oil leak somewhere."

Stan raised the car a bit, and scampered underneath. In a few seconds he called, "I've found it, Gus—it looks like the rear main crankshaft's oil seal."

"But I haven't seen any oil puddles on my driveway," Carl protested. "Just a few drops—not enough to matter."

"That's because it takes high engine r.p.m. to pump oil past the seal. Most of the leakage occurs when you're on the road," explained Stan. "Your driveway gets just what drips off the oil pan."

"Sounds logical," Carl agreed.

Stan's explanation triggered a bell in Gus's mind, but his train of thought was interrupted by a beeping horn.

A '57 Olds sedan rolled through the gap left by the open overhead door.

"My ignition system is acting up in this rain, Gus," shouted John Burke. "Sell me a can of waterproofing spray, quick." He pointed to several florist's boxes on the rear seat. "I figured I'd deliver these flowers myself on the way home from the shop. They're due at a wedding in 40 minutes."

Gus bowed. "Anything to speed the town's cupid on his romantic rounds."

Burke wielded the aerosol can under the hood like a man spray-painting a room. When he yanked the spark-plug leads loose, Gus erupted.

"John!" he yelled. "Those are fragile cables, not weeds. Better let me check . . ."

"No time, Gus," Burke bellowed, spraying the plug insulators and quickly replacing the connector clips.

The engine coughed to life—backfiring once or twice—and the car backed out hesitantly as Burke floored the accelerator.

Gus watched the Olds turn onto Main Street, hiccough its way for another block, and stop dead. A moment later, Burke emerged, raised the hood, and began moving frantically around the front of the car.

Gus shook his head sadly. "Drop the oil pan on Carl's car and check the rear seal," he told Stan. "I'd better rescue our heavy-handed horticulturist."

Working deftly with a wire cutter and a special crimping tool, Gus fashioned a new set of high-voltage spark-plug cables for the Olds in less than 15 minutes. As he worked, a glum John Burke sat next to him inside the tow truck. Finally, Burke spoke.

"Okay, Gus, what did I do wrong?"

Gus held up one of the old cables he was using as a length gauge. "This kind

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of ignition cable," he explained, "uses a thin carbon filament—not a metal wire—as the center conductor. The filament is fragile. When you yanked the cables loose from the plugs, you pulverized the filament, opening up all kinds of internal gaps. It's surprising that the engine started—from the sound of it, it was running on only a few cylinders.

"The short bumpy ride finished the job—the little gaps became big gaps, too wide for the high-voltage ignition pulses to jump across, and the engine died."

Gus installed the new cables, and the engine roared to life. "If you hurry," he said, "you'll get there for the first note of 'Here Comes the Bride.' "

"The oil seal looks okay," said Stan, as he handed the engine's rear main-bearing cap to Gus. "No sign of wear on the seal, and the crankshaft is smooth as a whistle where it contacts the seal."

Realizing that Carl was peering over his shoulder, Gus pointed out the seal element.

"The complete seal forms a tight-gripping circle around the rear end of the crankshaft. It's designed to keep the oil that's splashing around the crankcase from leaking out of the engine. Half the seal fits into this bearing cap; the other rests in a groove in the engine block."

Gus scratched his chin and looked quizzically at Stan. "Could the leak be somewhere else?" he asked. "And the oil travel to the back of the oil pan?"

"I checked that," Stan said. "The rest of the engine is spotless."

"Must be magic," said Carl, firmly.

Stan and Gus were jolted out of their puzzled state. They both said "What?" almost simultaneously.

"What else but magic could pump oil past a perfectly good oil seal?"

The little bell in Gus's mind began to ring again. He turned to Carl. "The answer is obvious," he said in a delighted voice. "An oil pump, of course!"

Through Gus's memory flashed the details in a service bulletin he'd read last fall. It described one of the strangest factory goofs he had ever heard of. Sliding under the lifted car on a creeper, he aimed his flashlight beam at the back end of the massive crankshaft. In a moment he was back out, a grin on his face.

"Break out the extra creepers, Stan," he said. "You'll both want to get a look at this one."

Under the car, Gus pointed to a narrow band of diagonal lines cut into the crankshaft near its rear end.

"That band of knurling," he explained, "is supposed to act like a rudimentary oil pump that works whenever the crankshaft is turning. You'll notice that the band is located just ahead of the oil seal. The knurls are supposed to catch drops of oil that are sliding down the shaft towards the oil seal, and hurl them away—sort of like a tiny turbine.

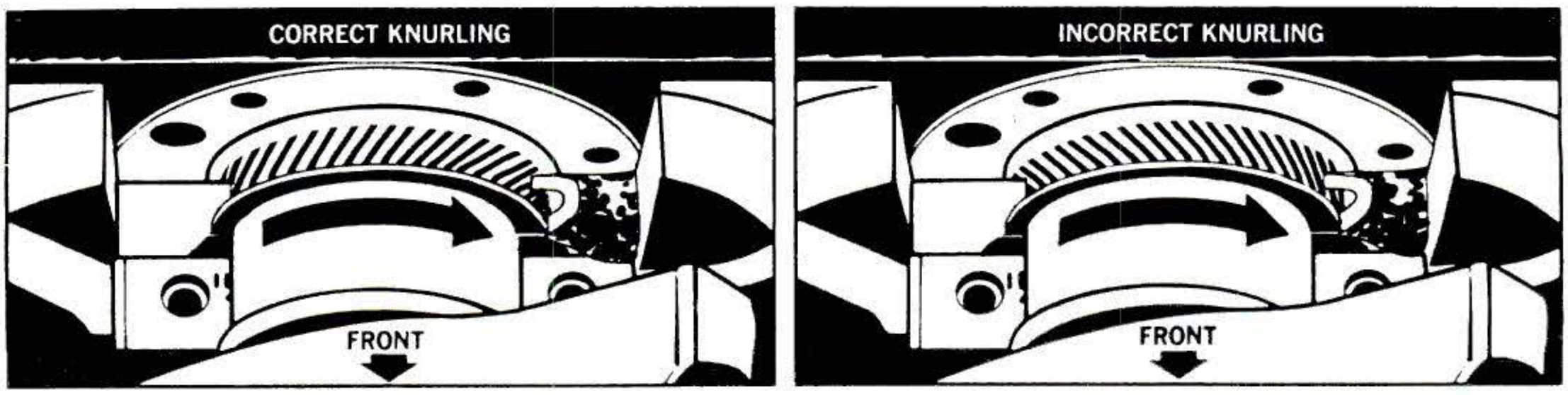
"Unfortunately, the machine that made this crankshaft cut the grooves backward—they're pitched toward the oil seal, not away from it. As a result, oil drops are hurled directly at the seal—and are actually pumped through it. The seal was never designed to withstand that kind of treatment, so it leaks oil."

"What's the cure?" asked Carl, after the trio slid out from under the car.

"There's only one," answered Gus. "A new crankshaft.

"And there's no doubt," Gus added, "that this is a factory-caused flaw and should be repaired under warranty. I'm sure your dealer will agree."

"How can he refuse?" asked Stan. "One bad turning deserves another." PS



The crankshaft grooves were cut backward—pitched toward the oil seal, not away from it.

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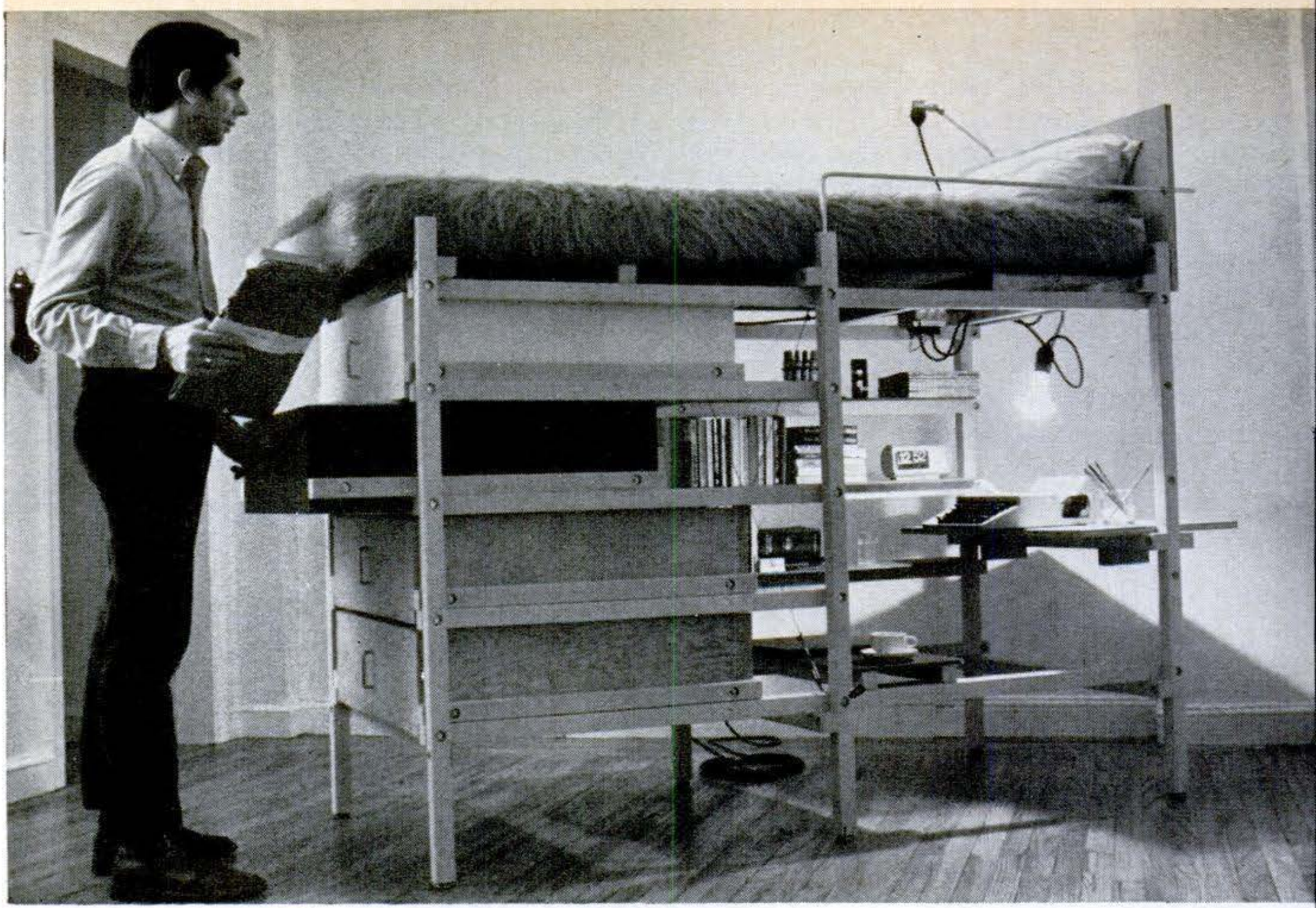

PS PROJECTS

How to Build the

It's a bed, it's a desk, it's a chest—all in one Living Structure of wild new design

By KEN ISAACS
Director, Matrix Research Project

A psychiatrist who is a research specialist in child adjustment tells me that my newest Living Structure does great things for a child. It satisfies, he says, the "territorial imperative." In plain language, this means that the structure makes the child feel more secure and independent by giving him a place he can call his own.

The Microdorm integrates a bed, study-work-eating area (with seating), bookshelves, lighting, and more than 16 cubic feet of drawer space for clothing and tools (approximately the storage capacity of two ordinary chests of drawers). All these functions are organized within a geometric Matrix framework of my design that takes up the same floor space (three by six feet) as an army cot. This multiplicity of uses is available *all* the time without the necessity of making adjustments or moving any elements.

Like my Superchair, which appeared in the March, '68, issue of POPULAR SCIENCE, the Microdorm is an expression of the Matrix Idea in design. Traditional design is concerned with fragmented solutions to one aspect of a problem; the Matrix Idea attacks the whole problem at once and aims at providing the hardware for a new way of life.

The Microdorm was conceived as a Living Structure that could grow up with a child. He can begin using it at five or six. It should mean a lot to the

[Text continued on page 216]

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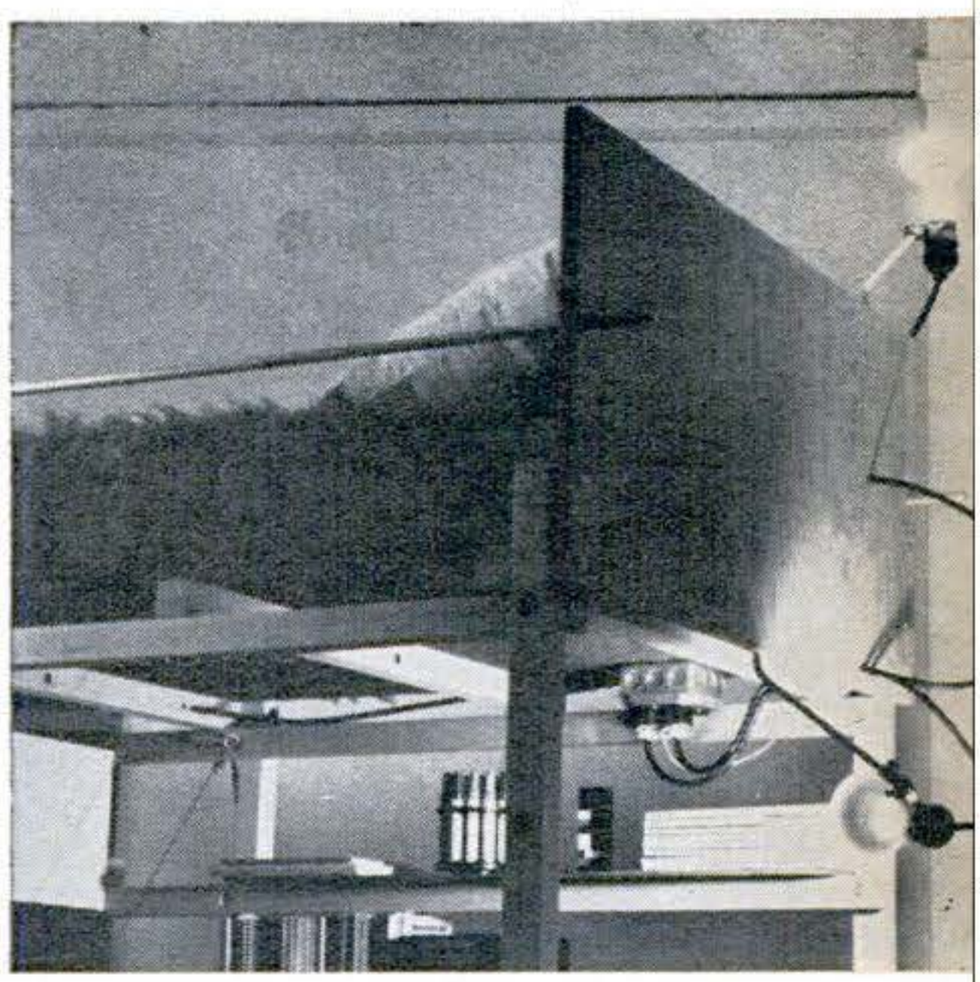
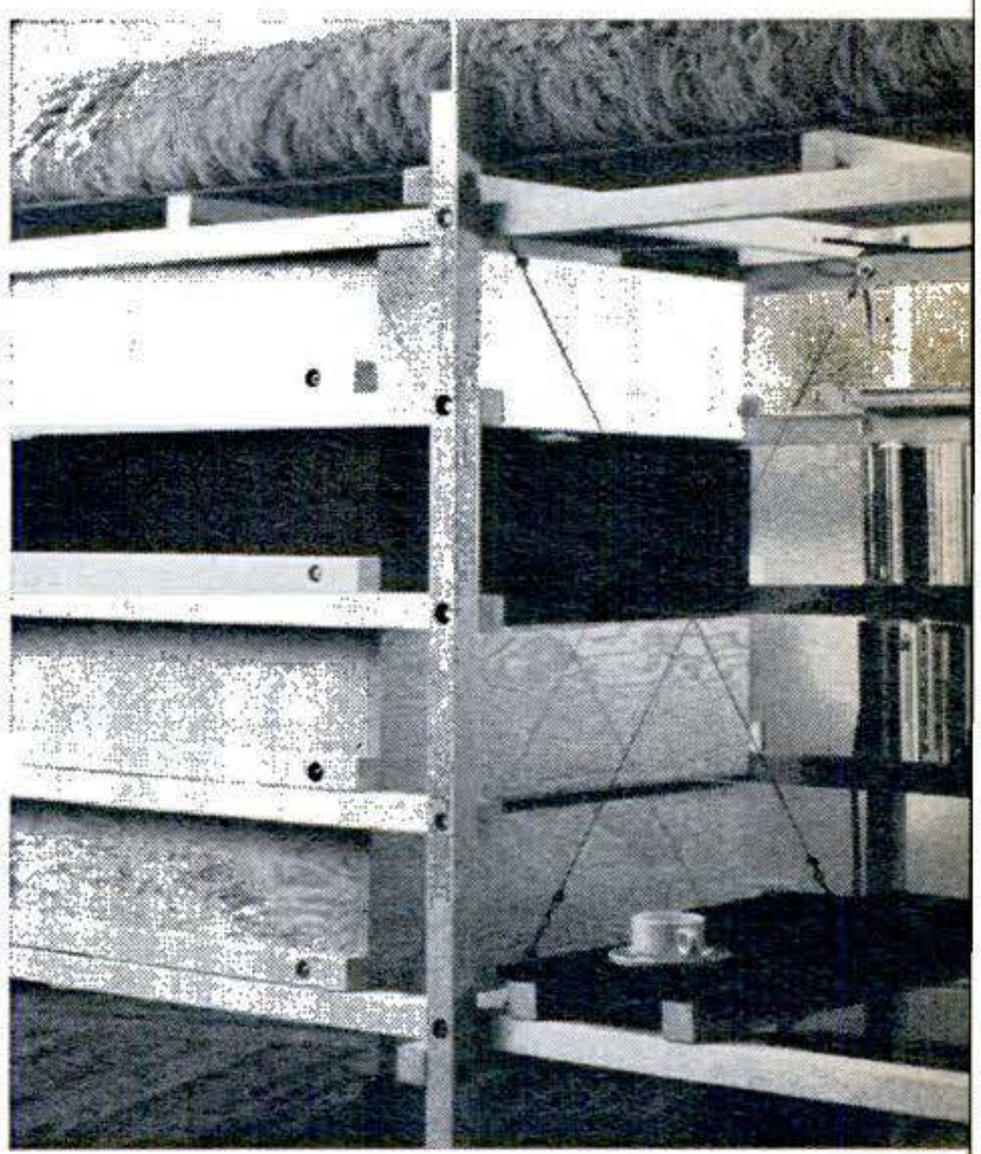
Newest Living Structure is first Isaacs has designed specifically for the young. A small house within a room, it includes drawer storage and a full-length bed topside (demonstrated at left and above by the designer), plus a private study with seat, table, and bookshelves.

MICRODORM



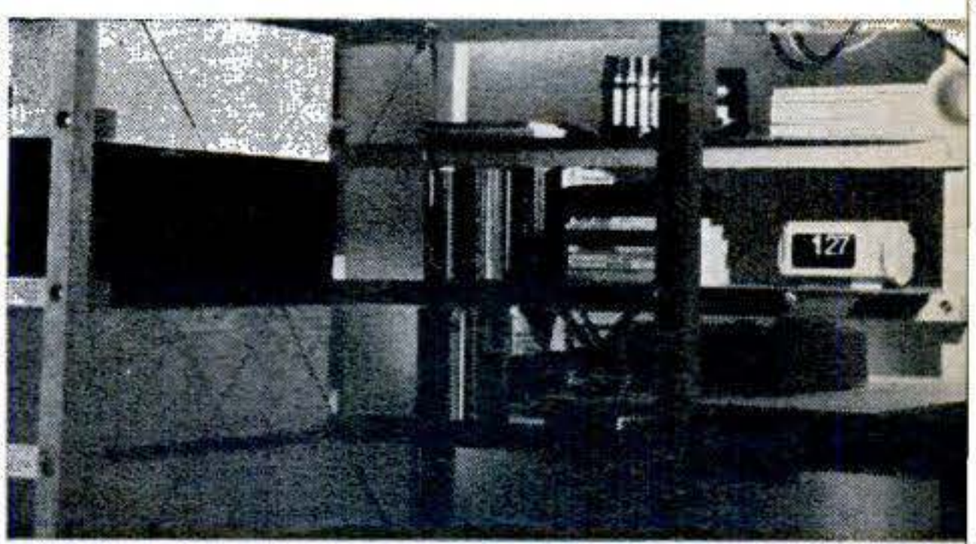
Integral lights on headboard and over work table plug into outlet that's visible under the bed. So do electric tools, clock, or typewriter.



Wire crossbracing in middle frame makes unit fully rigid. Drawer support rungs serve as a ladder to reach bed for casual study, sleep.

Turn the page for lie-flat blueprint

Study area is a total work center with equipment close at hand. Light pivots on arm with adjustable ball joint at socket clamp; cords thread through holes in headboard. A loose cushion can be used on seat, which adjusts by sliding back and forth on lowest side members.



Hardboard shelves next to the work table hold books and equipment. Table clamps to crossmembers with two-by-two blocks, 4⅞" long.

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MATERIALS LIST

TWO-BY-TWO CUTTING SCHEDULE (lengths)

- 6 52"—verticals
- 7 72"—longitudinals
- 3 36-13/16"—drawer supports
- 8 36"—crossmembers
- 4 32¾"—bed-panel supports and seat supports
- 2 12"—seat supports
- 8 29"—drawer slides

HARDWARE

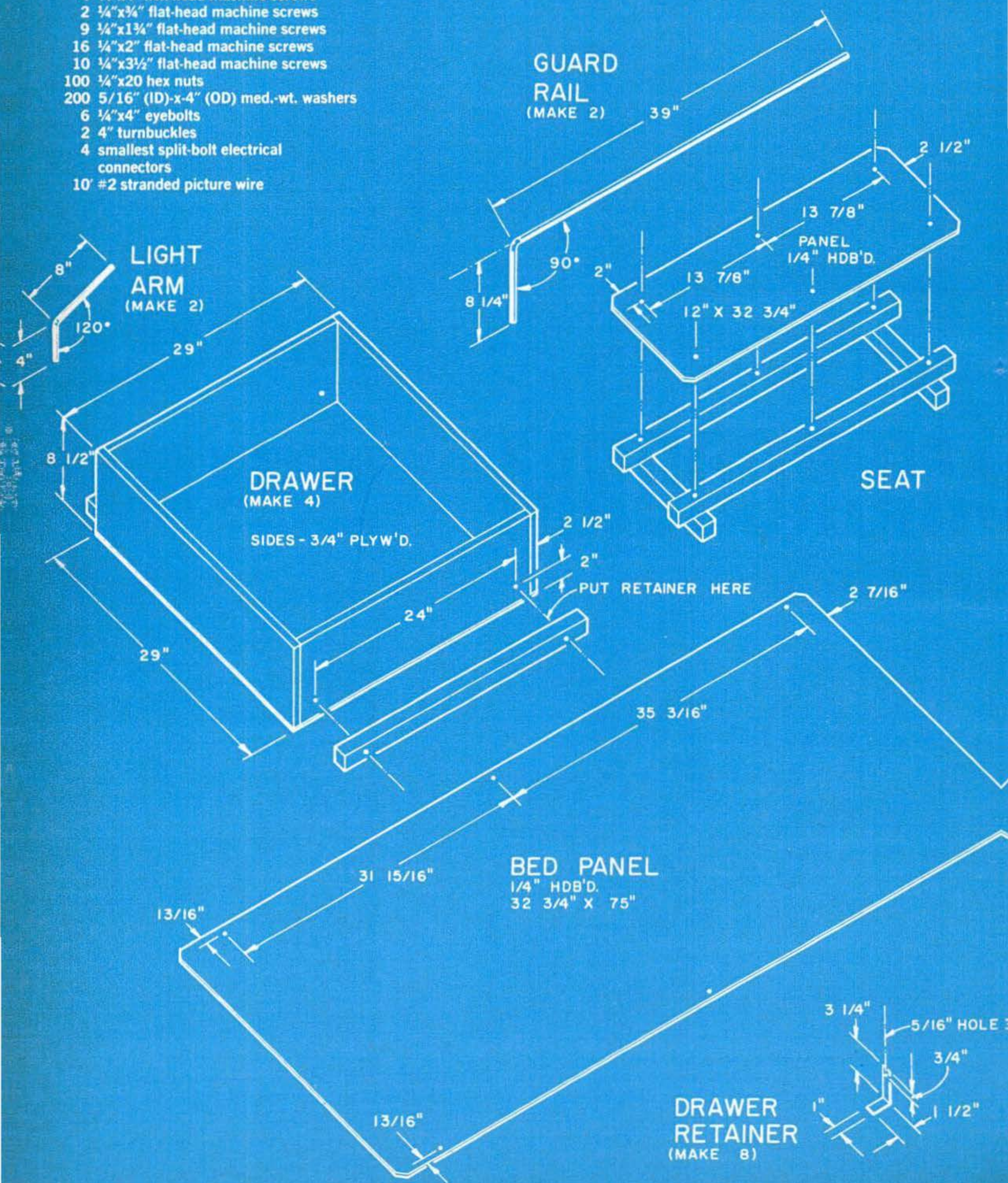
- 43 ¼"x2½" hex-head machine screws
- 4 ¼"x4" hex-head machine screws
- 2 ¼"x¾" flat-head machine screws
- 9 ¼"x1¾" flat-head machine screws
- 16 ¼"x2" flat-head machine screws
- 10 ¼"x3½" flat-head machine screws
- 100 ¼"x20 hex nuts
- 200 5/16" (ID)-x-4" (OD) med.-wt. washers
- 6 ¼"x4" eyebolts
- 2 4" turnbuckles
- 4 smallest split-bolt electrical connectors
- 10' #2 stranded picture wire

ELECTRICAL SYSTEM & LAMPS

- 2 ball-joint socket clasps
- 2 sockets w/integral switch
- 3 Hubbell heavy-duty rubber plugs
- 1 square outlet box w/cover
- 2 duplex receptacle inserts
- 20' med.-wt. rubber-insulated electrical cord
- 2½' ⅜" aluminum rod

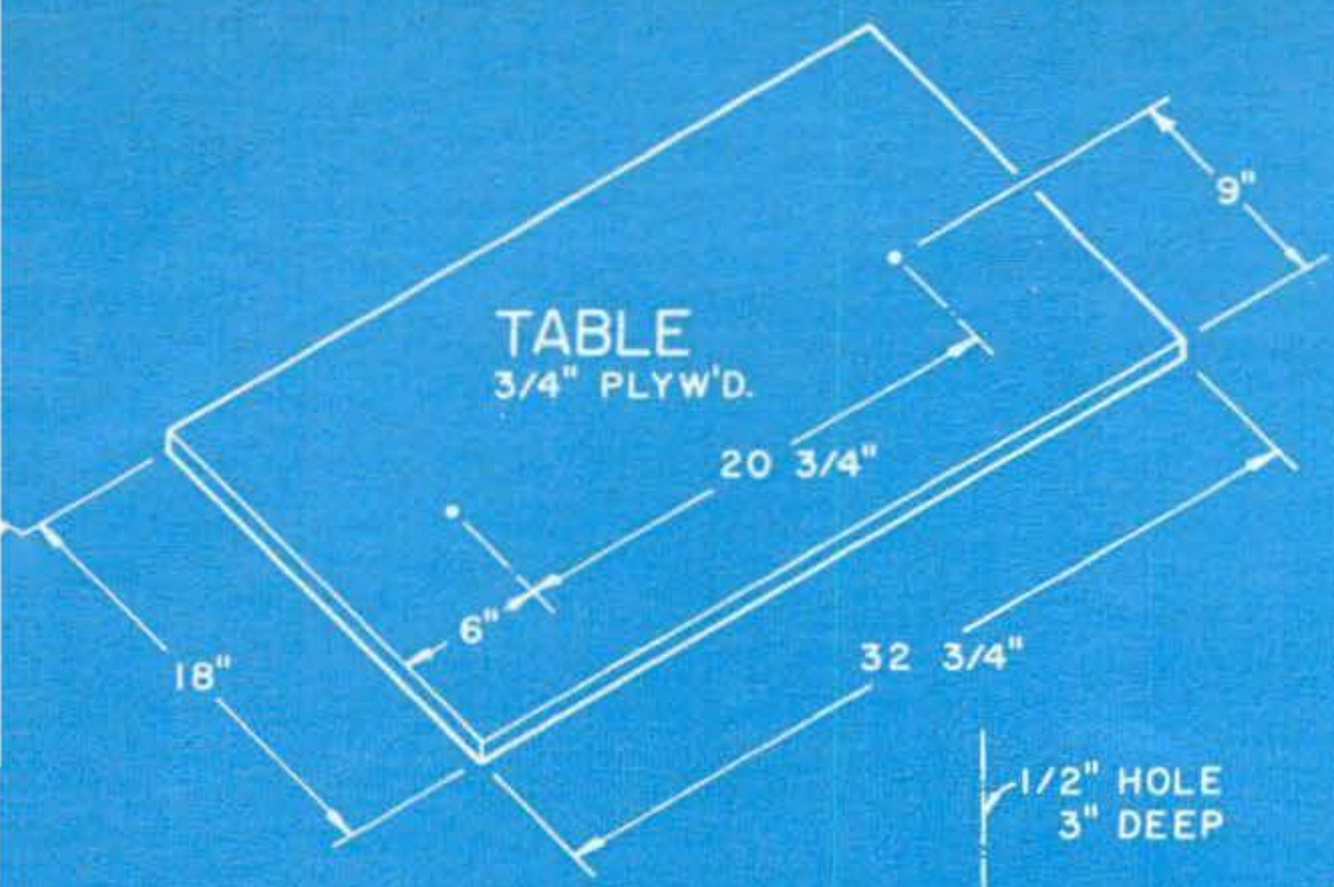
MISC.

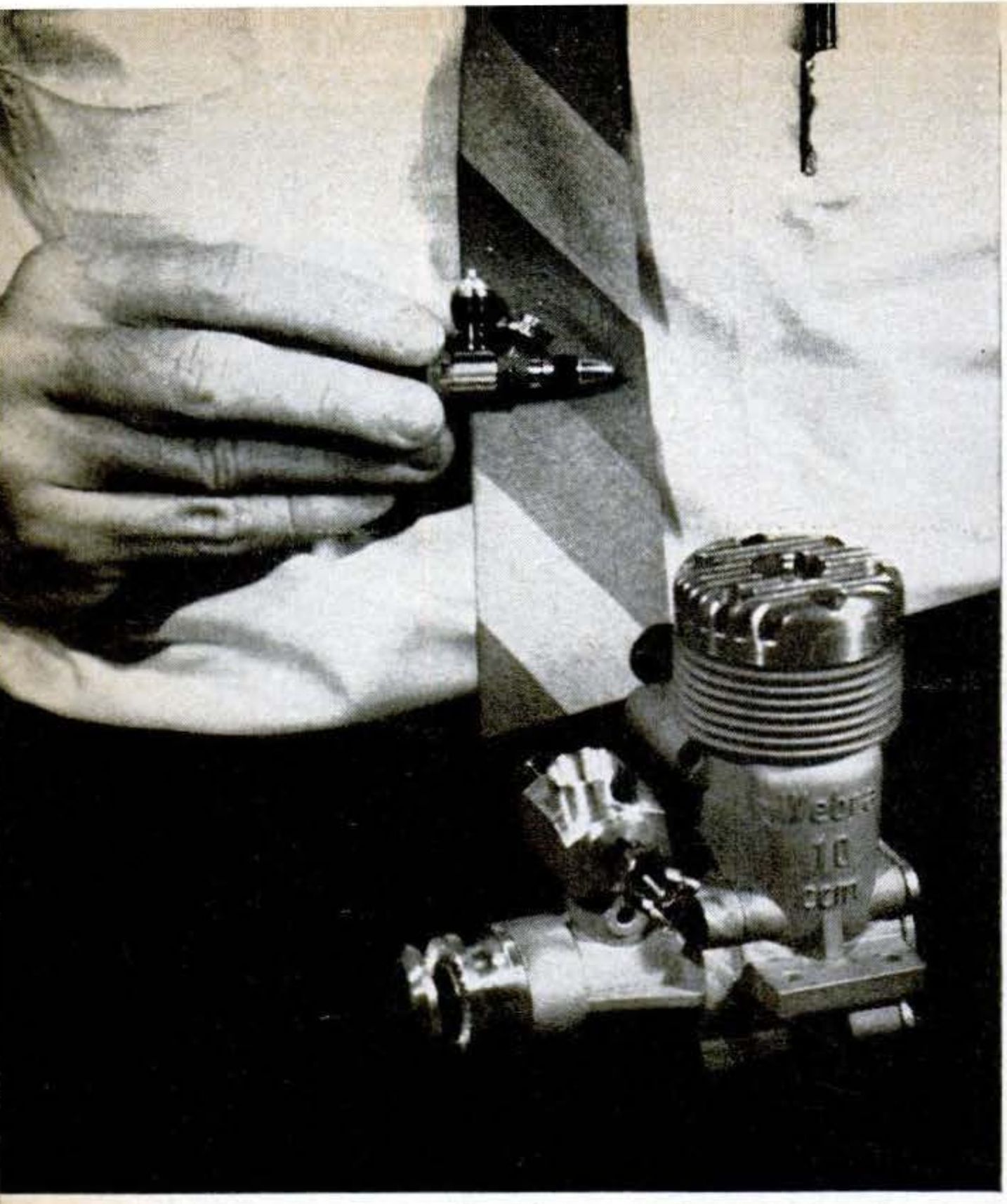
- 8 ½"-high rubber bumpers w/integral screw
- 6 1½" glides
- 8' ½" round aluminum rod
- 48" ⅛"x1" aluminum strap
- 4 #751/U526 chrome U handles (by Colonial Hardware, Torrington, Conn.)

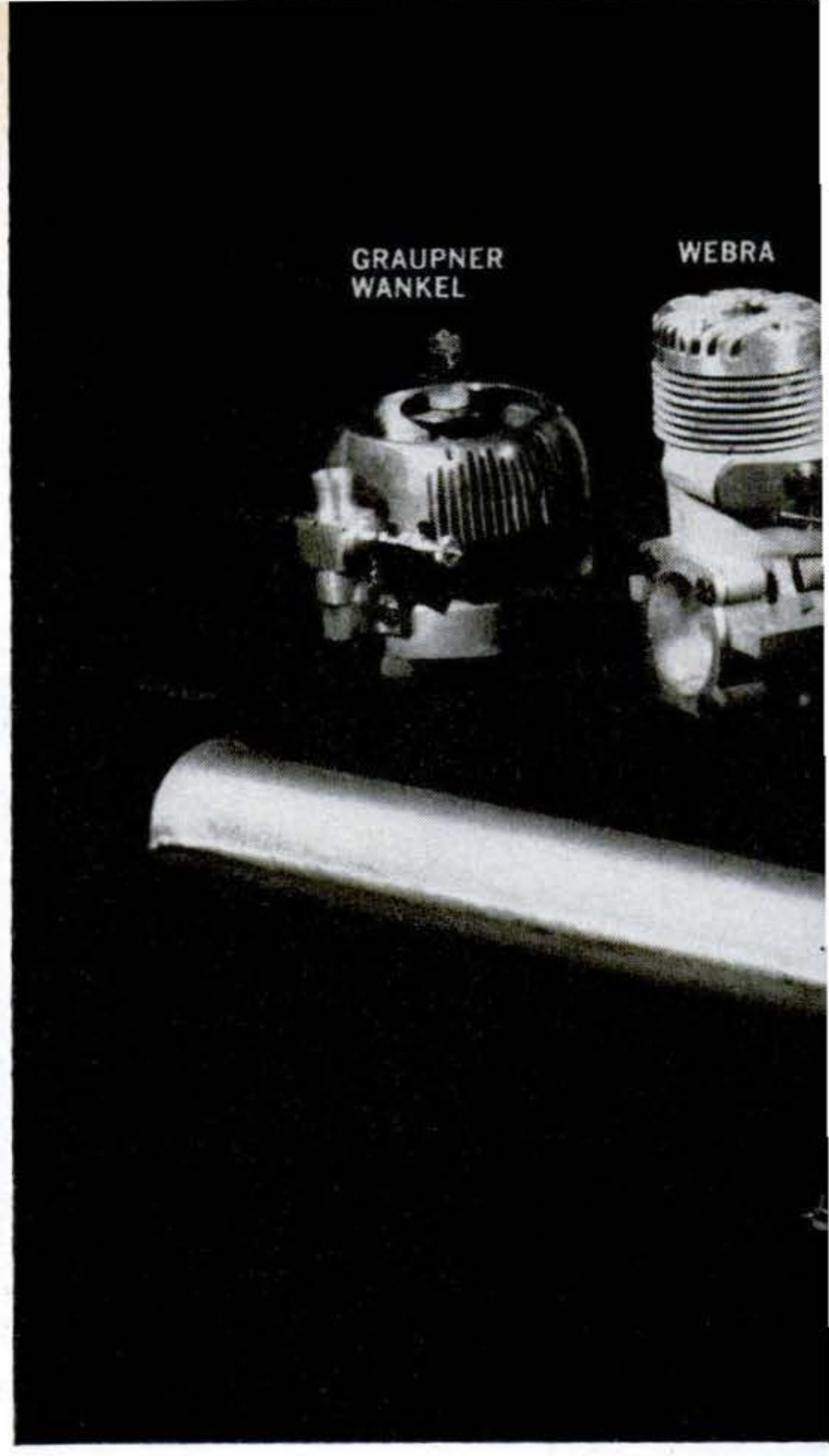


PS LIE-FLAT BLUEPRINT

MICRODORM







Tie-clip mounted, .01-cube L.M. Cox Co. glow engine is not recommended for shirt-front operation. Other extreme in glow-engine size is .61-cu.-in. Webra (foreground), equipped with ball-bearing crankshaft, ringed piston, adjustable-speed carb.

The Wonderful World

Seldom seen in hobby shops, but marketed by mail, new midgets beef up planes, boats, and cars

By HOWARD G. McENTEE

Hobby-shop shelves are loaded with finely crafted single-cylinder glow engines. The largest of the two-cycle jobs will loft a six-foot plane, and the smallest, weighing less than half an ounce, are jewel-like enough to be offered as tie-clip ornaments. Replace the clasps with fuel tanks and they crank out 27,000 purposeful r.p.m.

Given these dependable power plants, offered at modest prices only because

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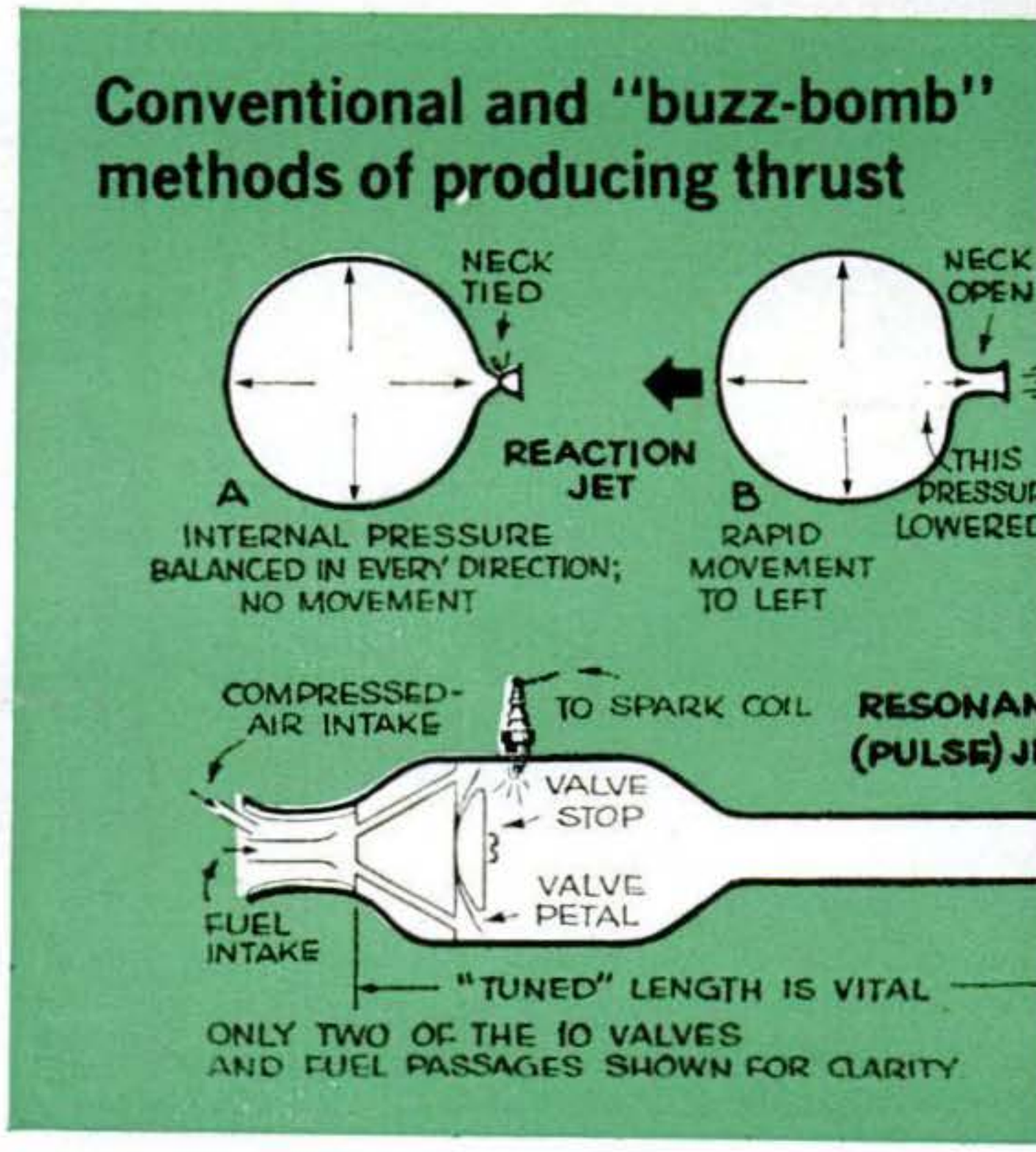

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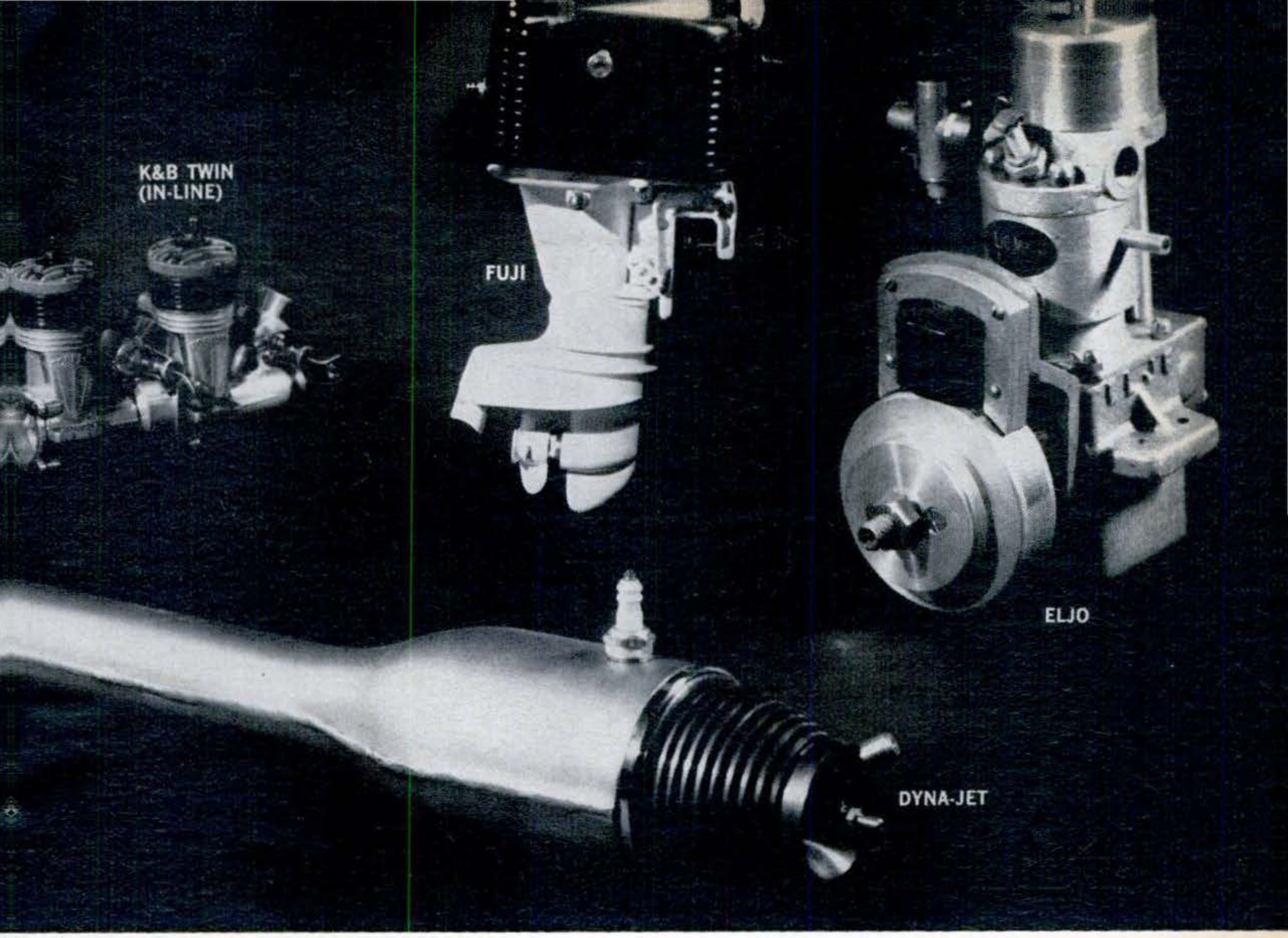
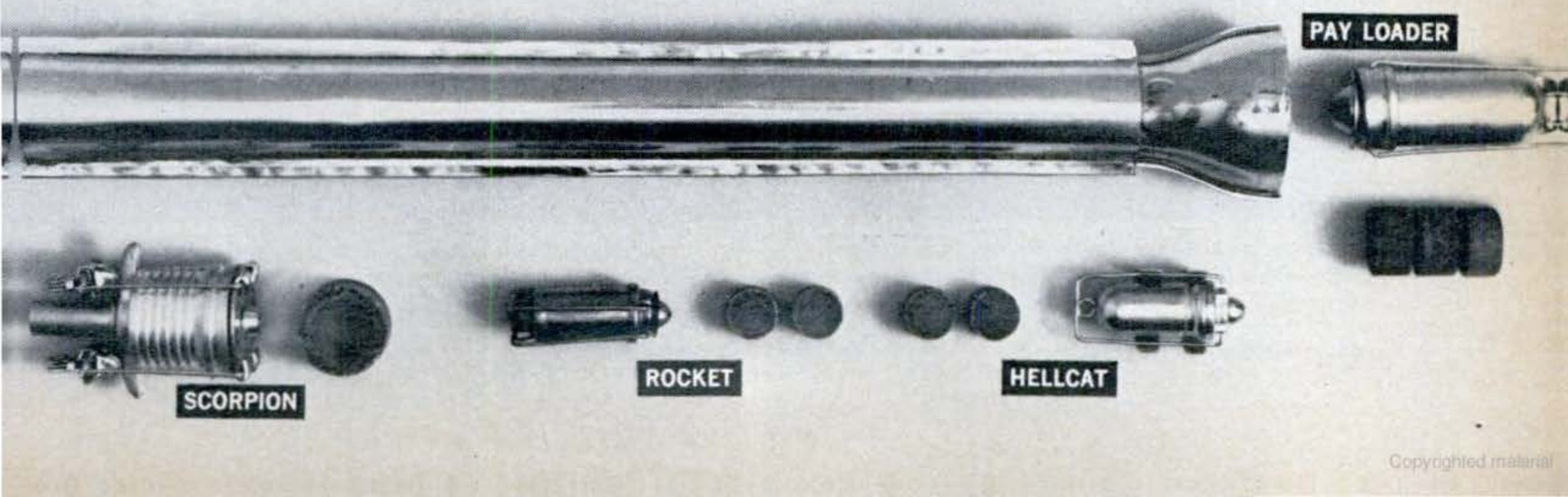


# of Model Engines

Nose unit of powerful Dyna-Jet, at right, holds gasoline and compressed air. Vaporized fuel passing through leaf valves is ignited in a combustion chamber. Each flaming thrust closes the valves momentarily. Result is a buzz-bomb-like, pulse-jet action.

Long augmenter tube, below, adds 25 percent more thrust to Jetex's Payloader 150 shown at its mouth, and to the Scorpion 600 at lower left. These and smaller reaction-jet engines, the Hellcat 50 and Rocket HT 50, run on disk-shaped fuel pellets.



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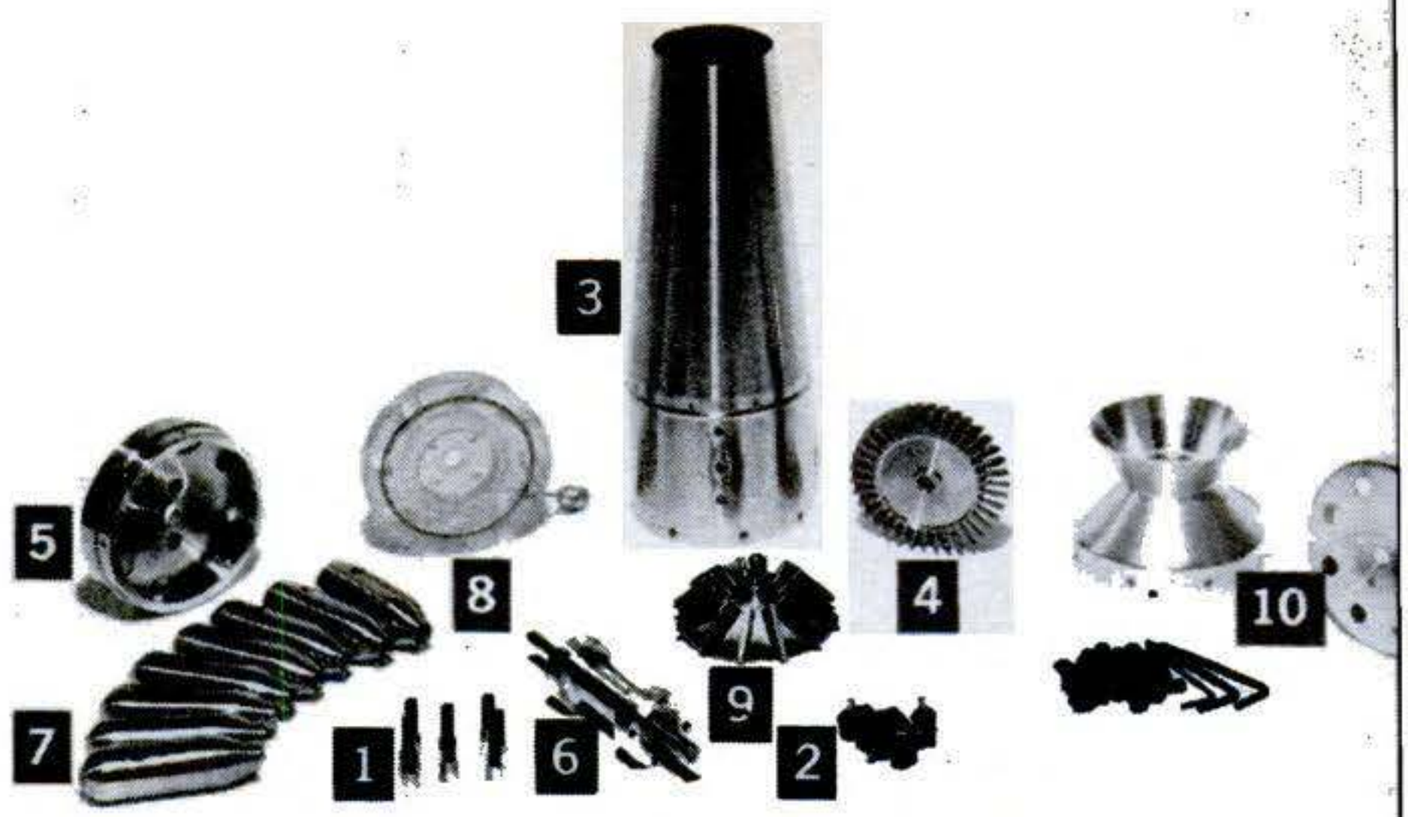
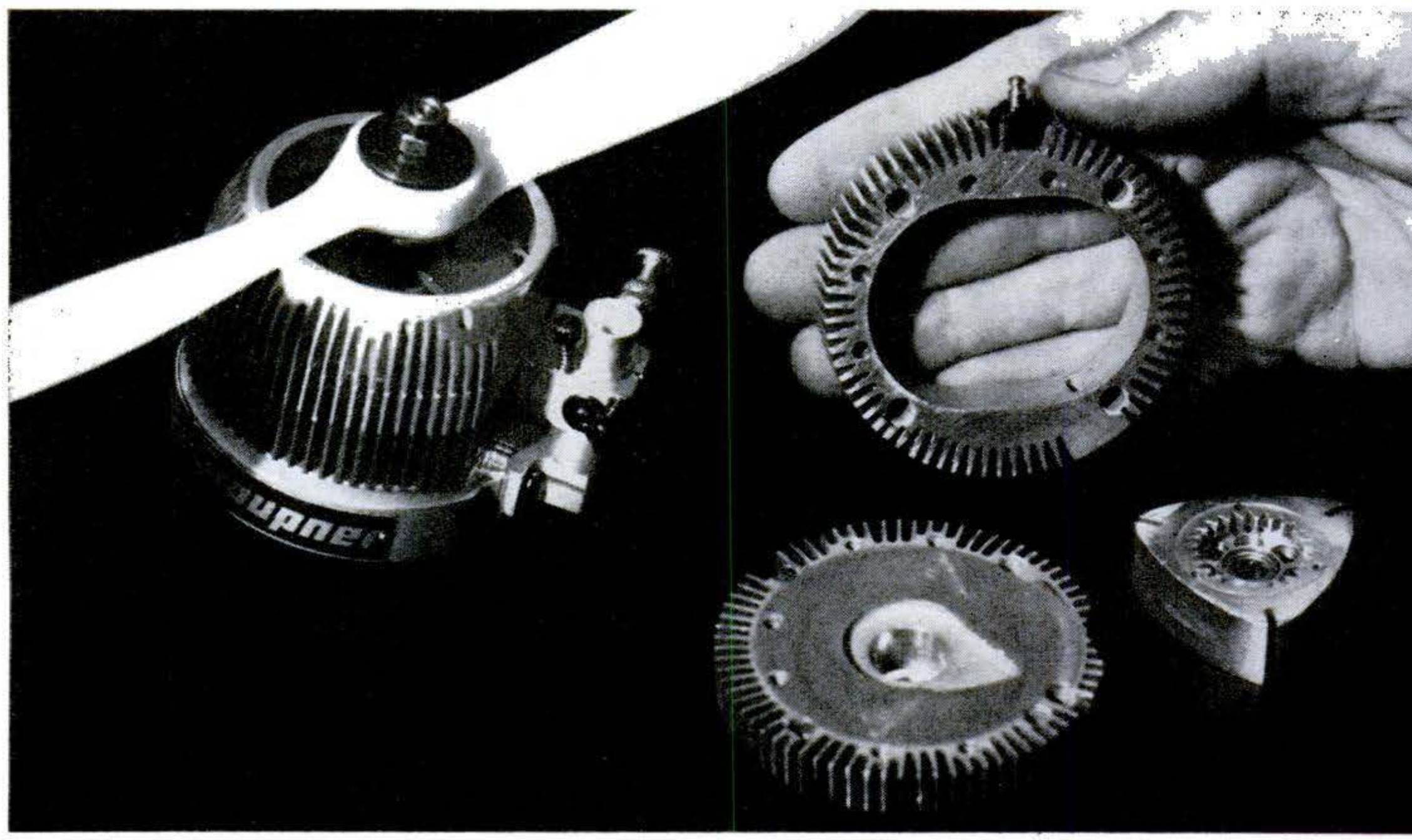
Diesel dwarf, .15-cu.-in. Super Tigre ignites fuel with heat of compression controlled by cylinder-head lever.



Space-program-priced at $450, Turbocraft's U-22-D turbojet comes as kit, too ($189.50), with: 1) combustion-chamber inserts; 2) plugs; 3) exhaust tube, cone, stabilizer; 4) turbine wheel; 5) turbine-

they are mass-produced, you'd think the model fraternity would be happy. Not so. Sophisticates frown upon powering their flying saucers, hydrofoils, and Bonneville brutes with the kind of engines small boys find among the walnuts in their Christmas stockings. They complain that the two-cycle mills burn excessive droplets of fuel, and that a large one-lunger can shake a model to bits.

Model turbojet. Fortunately there are esoteric alternatives. For $450, a South Carolina firm named Turbocraft puts out an eight-combustion-chambered working model of a turbojet. This costly "blower" is intended mainly for school and industrial demonstrations and research —although a few courageous modelers have actually sent the hardware aloft. Either way, the manufacturer recommends two extras. One is an electric starter, to give the shaft the 15,000 r.p.m. without which the unit won't flame into action. The other is an afterburner that



Graupner's Wankel behaves as handsomely as it looks. Between a modified-figure-eight cavity and a triangular rotor are formed what amounts to three revolving cylinders. Carbureted fuel enters through a pear-shaped recess in one side wall. As rotation continues, a glow plug ignites it. Then a slot (shown

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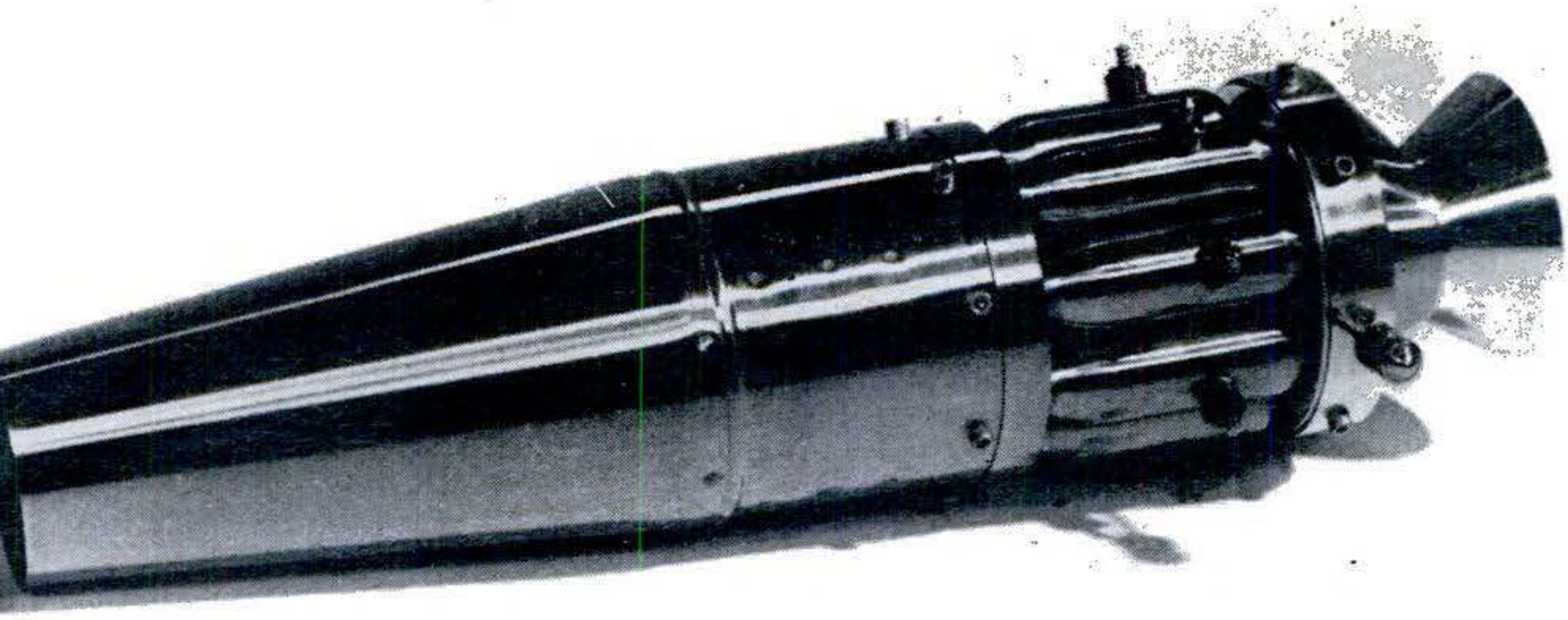

nozzle section; 6) shaft, bearings, housings; 7) combustion chambers; 8) fuel injector-diffuser; 9) compression impeller; 10) compressor housings.

will nearly double the engine's thrust.

At the economy end of the jet-propulsion line are four small bundles from Britain carrying the Jetex trademark. Working on the reaction principle, they are powered by solid-fuel pellets shaped like aspirin tablets, and no more dangerous to handle. Given the right dosage, ignited by a match or punk, these tiny rocket engines produce predictable thrusts and running times.

The buzz bomb. The most awesome jet

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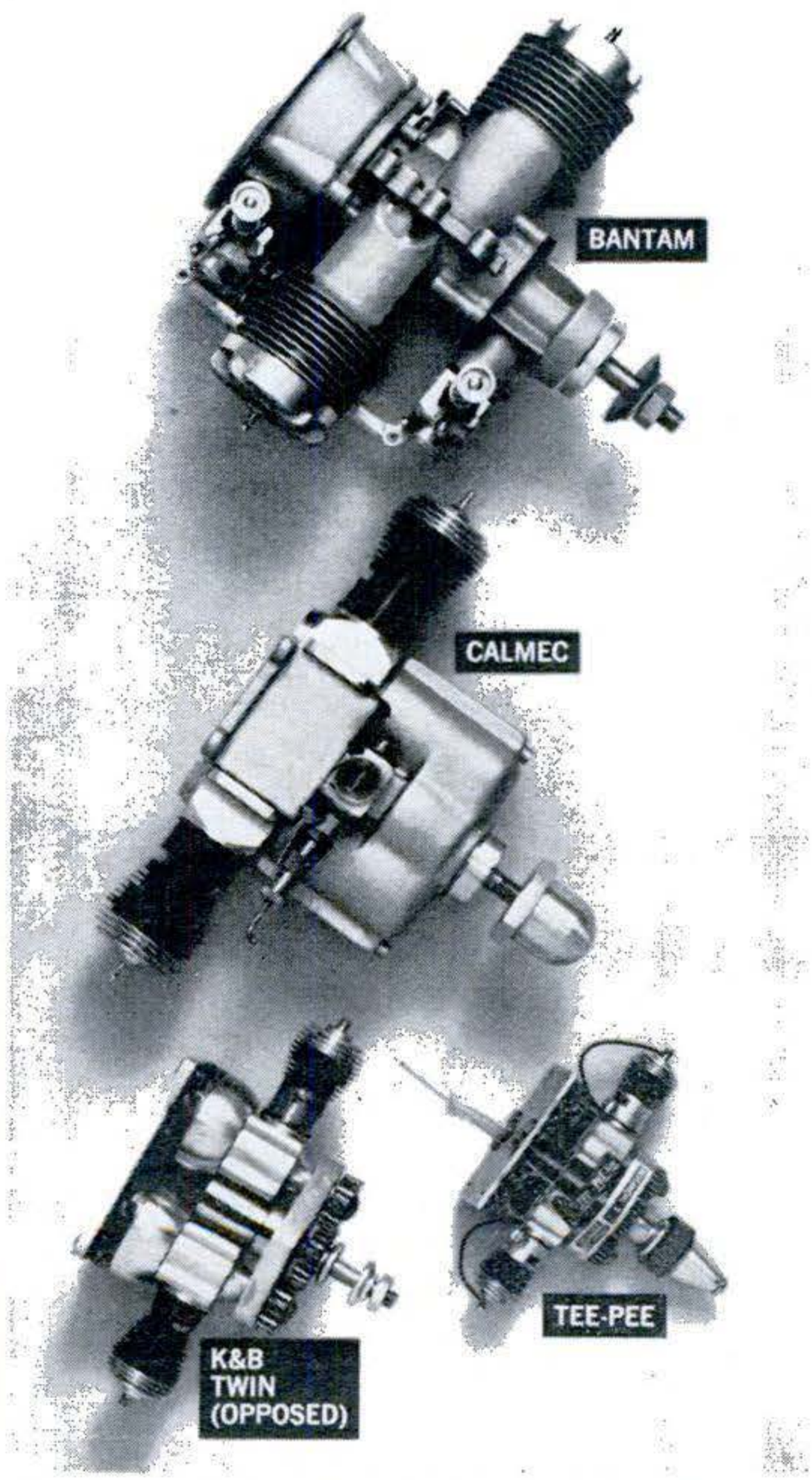
near bottom of hand) voids the exhaust. The rotor's internal gearing triples the shaft speed. The engine runs smoothly, and its four-cycle action saves fuel.



Opposed cylinders boost power and reduce vibration. Slightly offset, those of Bronner's .60-cube Bantam Twin, at top, stroke a single crankshaft. Although each cylinder has its own intake and exhaust throttle, all are linked together. The other three twins use Cox engines geared to a common drive shaft. The largest is Calmec's .30-cu.-in. XA-902, featuring a gear housing and a single intake and throttle. Midgets are Flight Control Products' Twin Opposed K & B, and J. A. Thompson's Tee-Pee.

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performer, however, is an Indiana outfit's offering called the Dyna-Jet. Made of heat-resistant stainless steel, it rips along on a succession of fuel-valve-controlled power pulses. Its buzz-bomb-like roar is not appreciated in congested areas. But tether-controlled in an open field, with a wing and tail assembly strapped on, it becomes a thing of glowing beauty as it eats up space at nearly 200 m.p.h.

Returning to reciprocating engines--the one-armed glow-plugger becomes a conversation piece when Japan's Fuji Bussan Ltd. tricks it up to look and behave like a sassy outboard motor. Highlights are a water-cooled cylinder, a tilting and swiveling transom mount, and a shearpin-protected propeller.

To prevent vibration, several builders turn out two-cycle opposed twins. Because their power strokes are applied simultaneously and in opposite directions, they should run as smoothly as electric motors. That some don't is due mainly to fuel-distribution problems. In general, twins that are actually two separate engines geared to one shaft are favored over true "unit" twins whose rods both stroke a single double-throw crankshaft. Another solution is to place two engines in tandem.

Diesels anyone? Purists prefer to call Italy's Super Tigre and others of its type "compression-ignition engines." That's because they use a special fuel containing ether as an igniting agent, rather than an injector. Whatever the name, they eliminate a battery and glow plug.

Finally, there are the four-cycle mills. With their relatively low power-to-weight ratios, husky midgets like Germany's Webra RC rarely get both feet off land or water. But the three-cylinder action produced by the unorthodox new Wankel design just going into production holds great airborne promise. PS

How the New Engines Stack Up

NAME	SOURCE	WEIGHT (ounces)	WIDTH (inches)	HEIGHT (inches)	LENGTH (inches)	DISPL. OR THRUST	PRICE	REMARKS
Bantam Twin	Bronner Mfg. & Tool Co., Hanover, N.J.	18.7	6.75	2.75	4.25	.60 cu. in.	Approx. $75	Weight includes rear mounting plate, dual intake, and exhaust throttles
Calmec XA-902 Twin	Calmec Mfg. Div. of Ametek Corp., Los Angeles 90022	14.65	6.25	2.25	3.12	.30 cu. in.	$45	Workmanlike assembly; single intake and throttle; enclosed gears
Cox .01	L. M. Cox Mfg. Co. Inc., Santa Ana, Calif. 92702	.47	.875	1.37	1.18	.01 cu. in.	$8.98	Price is with fuel tank doubling as mount; tie-clip model priced higher
Dyna-Jet	Curtis Dyna-Products Corp., Westfield, Ind.	14.5	2.5 dia.	—	21.5	4.25-lb. thrust	$39.50	Tail section is 1.25-inch diameter; spark plug projects one inch
Eljo Mark II	Dist. by Polk's Hobbies, 314 5th Ave., NYC 10001	78.4	4	7	5	.70 cu. in.	$150	Made in England. Price of four-cycle engine includes tailpipe and muffler
Fuji Outboard	Fuji Bussan Ltd., dist. by Polk's Hobbies	16.3	2.62	7.75	4.2	.15 cu. in.	$29.95	Made in Japan. Propeller is 1.32-inch diameter. Engine tilts and swivels
Jetex Hellcat 50	Wilmot, Mansour Ltd., dist. by Polk's Hobbies	.2	.81	.81	1.81	.6-ounce thrust	$1	All Jetex models made in England. Weights do not include fuel. Hellcat gives 12-16-second engine run
Jetex Rocket HT 50	Wilmot, Mansour Ltd., dist. by Polk's Hobbies	.3	.75	.75	1.75	5-ounce thrust	$1.50	High-thrust, short-duration runs average 3-5 seconds. HT 50 weighs .5 ounces with a two-pellet charge
Jetex Payloader 150	Wilmot, Mansour Ltd., dist. by Polk's Hobbies	.7	1.12	1	3	2-ounce thrust	$2	Engine run is 10-12 seconds with 1.3-ounce pellet charge. Aluminum augmenter tube adds 25 percent to thrust
Jetex Scorpion 600	Wilmot, Mansour Ltd., dist. by Polk's Hobbies	1.6	1.68	1.18	2.37	6-ounce thrust	$4	Engine run is same as Payloader 150. All Jetex dimensions include mounting clip
K&B Twin In-Line	Flight Control Products, Salina, Kans. 67401	14.2	2	3.25	4.32	.30 cu. in.	$49.95	Big power for slim-cowled midgets. Special parts are sold separately
K&B Twin Opposed	Flight Control Products	15.56	5.25	2	4.12	.30 cu. in.	—	No price given; this is a special assembly built to order
Super Tigre .15 Diesel	Micromeccanica Saturno, dist. by World Engines, Cincinnati 45236	6.18	2.32	3.25	1.75	.15 cu. in.	$14.98	Made in Italy. Adjustable compression for starting and tuning. Engine also available with throttle
Tee-Pee .04 Twin	J. A. Thompson, dist. by World Engines	2.93	3.32	1.25	2	.04 cu. in.	$49.50	Also offered in a larger size, with pressure oil feed to driveshaft
U-22-D Turbojet	Turbocraft, Myrtle Beach, S.C. 29577	30	2.75 dia.	—	12	8-lb. thrust	$450	Machined-parts kit is $189.50. Options are afterburner and starter
Wankel	Johannes Graupner, dist. by Polk's Hobbies	13.45	2.63 dia.	—	2.12	.25 cu. in.	Not set	Made in Germany. Specs are for first model. Production jobs will be lighter
Webra .61 RC	Model Rectifier Corp., Brooklyn, N.Y. 11204	15.54	3	4	3.62	.61 cu. in.	$59.50	Made in Germany. Carburetor provides high- and low-speed adjustments

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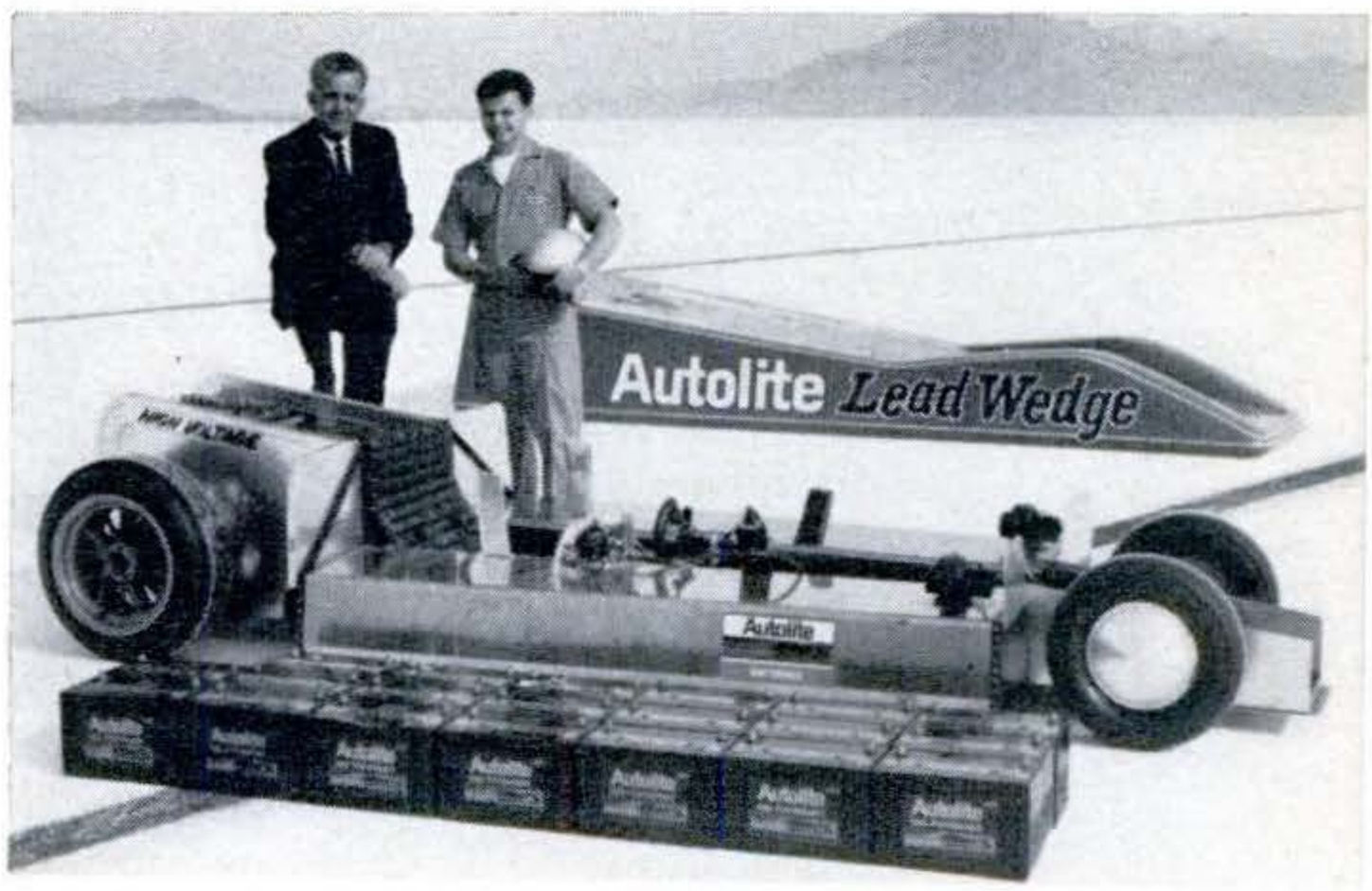
Electric speedster sets record with production batteries

The Lead Wedge, built by Ford's Autolite Division, holds the first U.S. Auto Club record for battery-powered cars—138.862 m.p.h. Twenty lead-acid production batteries put out up to 90 kilowatts. The rear-mounted 40-hp. GE motor is overloaded for speed runs, jacking power to 120 horses at 8,000 r.p.m. With its batteries aboard, the car weighs in at 2,060 pounds.



Lead Wedge's batteries must be recharged after each run. The 13-foot, 10-inch car has fiberglass body, aluminum chassis.

Almost submerged, 'dozer levels gravel at 17 feet.

Diesel on floating platform (rear) supplies power.

Diving 'dozer tested in Japan

This underwater bulldozer, controlled by an operator on the surface, can perform grading work to depths of 33 feet. Hydraulic lines connect the machine's drive and blade motors with a diesel on a floating platform. Claimed to be the first rig of its kind, it's made by the Japan Development and Construction Co. of Tokyo.

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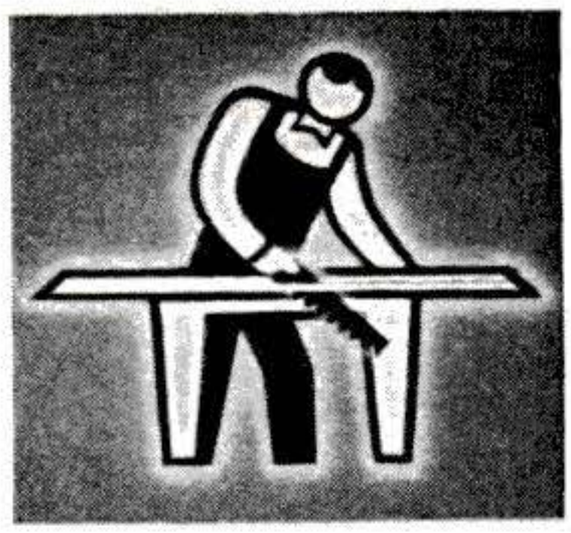
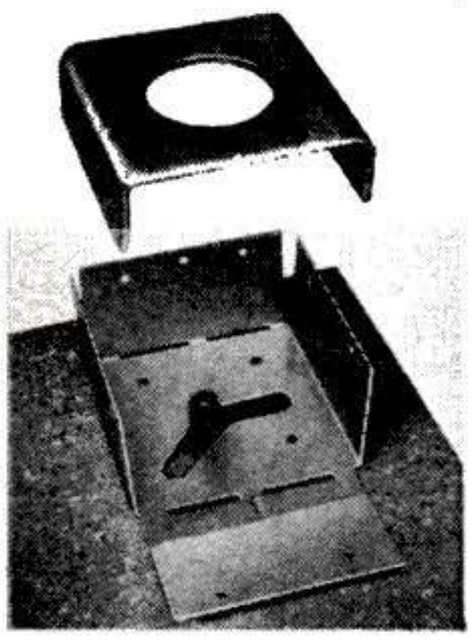


Shop Talk

By ROBERT P. STEVENSON

Products of interest to the man with a home shop



New steel base clips position four-by-four posts correctly (see photo) even though bolts embedded in the concrete below are out of line. The support plate keeps the post end 1 3/16 inch from rot-producing surface moisture. Panel Clip Co., Farmington, Mich. . . . U.S. Plywood's new Weldwood Foam-N-Tone is a product to try next time you have a staining job. Your choice: walnut, fruitwood, mahogany, maple, avocado, and driftwood. Six-ounce spray cans cost $1.98. . . . Molly anchors made by United Shoe Machinery Corp. now come in a choice of four colors. The screw heads are black, zinc, bronze, or copper to match decorative fixtures you may want to mount on hollow walls.

Literature that may give you new skills or improve your old

Know all about soldering? You're really good if you know all the facts found in the eight-page "Soldering Iron Application Guide" (GEC-1555), available free from General Electric, Distribution Svcs., Bldg. 6-205, Schenectady, N. Y. 12305 . . . And what about chain saws? A revised edition of "Chain Saw Operation," is offered by the Public Relations Dept., McCulloch Corp., 6101 W. Century Blvd., Los Angeles 90045 . . . With another summer on the way, "Hot Tips for Cool Profits," distributed by K-D Mfg. Co., 3575 Hempland Rd., Lancaster, Pa. 17604, offers help in servicing car air conditioners . . . And, finally, for all you sailing buffs who need to know about "Rope, Knots, Hitches & Splices," there's a 70-page booklet of that title with excellent show-how drawings. It's priced at $1.50 from Marketing Services, Puritan Mills, Box 22185, Louisville, Ky. 40222, or from merchants who handle Puritan cordage products. Scouts and scout leaders also would profit from this booklet.

How one company got its start in the fixit-product business

Back in 1920, Norman J. Freeman asked a garage man what to do when rust holes developed in the fenders of his Model T Ford. The garage man quoted repairs at $20, a big bill in those days. Young Freeman, who was of an inventive nature, thought there must be a less costly way. He mixed up ingredients which he felt might harden and fill the holes. The mix worked. His repairs cost 20 cents. Garage men expressed interest and Freeman set up in business to sell his product, Duro Auto Body Filler. That was the beginning of Woodhill Chemical Corp., a Cleveland company that now makes a long line of fixit products.

I learned this story when I asked for information about the company's newest product—Duro-Plastic Porcelain Glaze, available in white, avocado, and coppertone for touching up scratches and nicks in the finish of kitchen appliances, a job that eventually confronts every home owner. The new glazes do a fine job. The cost is 49 cents for a one-ounce bottle.

Tool catalogues that may help you find a product you need

Interested in a shop vac? Write to Shop-Vac Corp., 1 Industrial Road, Wood-Ridge, N. J. 07075 . . . Remington Arms, Power Tools Dept., Park Forest, Ill. 60466, has a catalogue of chain-saw accessories . . . For a catalogue of surplus bargains, send 25 cents to Airborne Sales, Box 2727, Culver City, Calif. 90230 . . . A quarter also gets a catalogue from A. Constantine and Son, 2050 Eastchester Rd., Bronx, N.Y. 10461.

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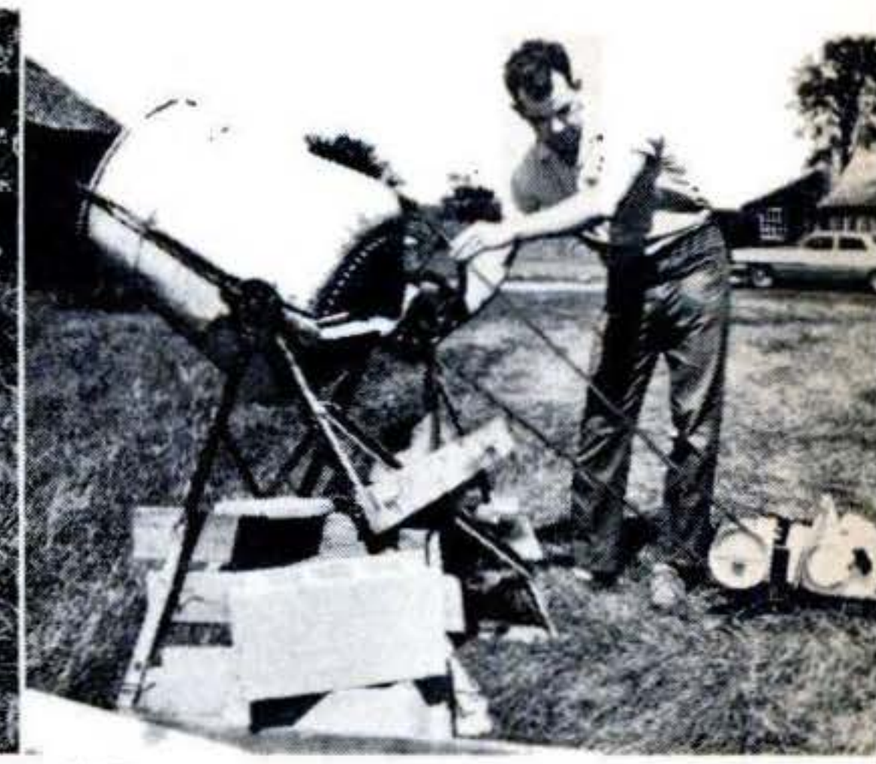
WHAT'S NEW

TOOLS

Chain saws get accessories

The makers of Pioneer chain saws now offer power accessories for their Holiday line. Models G and GT can be fitted with a long-handled brush cutter, selling for $99.95. A power-takeoff base ($22.95) adapts the saw's engine to such devices as a cement mixer. Also available: multipurpose cutter, air compressor, and water pump. An adjustable wrench installs the accessories. Pioneer Div., Outboard Marine Corp., Galesburg, Ill.



Chain saws with the pro touch

Three direct-drive chain saws for the nonprofessional are now available from Skil. Model 1631 (right) has a 15-inch bar, 4.2-cu.-in. engine with choke starting, manual chain oiler, flush-cut front handle. It's $199.95. Others are: model 1645, with fuel primer and automatic oiler, about $225; and 1661, with larger engine, 20-inch bar, $270.

Flameless gun gives wraparound heat

The AEROray Heat Gun uses a tungsten-filament quartz lamp to produce heat up to 1,350 degrees for soldering copper pipe, bending plastic tubing, from ⅛- to one-inch outside diameter. Available with 750- or 1,000-watt lamps, it works on either 115 or 230 volts. Price is $125, from Areojet General Corp., San Ramon, Calif. 94583.

Locking plier has C-clamp jaws

Called a one-handed C clamp, the LeverWrench will securely hold work up to 2½ inches thick. It needs no size adjustment—a knurled nut regulates jaw pressure. The lower jaw has a flat button designed for a wide bearing surface. A bottom lever releases the clamp. The $5.95 tool is made by Leverage Tools, Inc., Glenvil, Nebr.

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Beginning here: SHELVES, SHELVES, SHELVES

12 pages of tips, projects, and products to make your home a better machine for living with shelving for every type of storage and display. Just pick the ideas best for you

How to Add Shelves All Through the House

Whether you build from scratch or assemble ready-mades, you can tailor shelving to room needs

Is your home what the architect Le Corbusier called a "machine for living"? Adding shelves is one sure way to increase its efficiency.

Innumerable spots in most houses call out for them: Waste space above and below clothes hanging in closets, kitchen corners, blank living-room walls, bathroom areas below lavatories or over toilets, garages and carports, even those wasted spaces between the studs of any framed wall.

Basic material is softwood shelving, most often Ponderosa pine on one-by-12 and narrower dimensions. In one-by-four size, pine or Douglas fir is just the thing for narrow shelves that tuck between those studs that we've mentioned.

For wide shelves, for which solid lumber can seldom be obtained and may present a warp problem, plywood is an excellent bet.

A little browsing in lumberyards will turn up other things. Precut particleboard shelves in a variety of sizes are a great time saver. For small shelves, sink cutouts already surfaced with plastic laminate are a bargain at a price often little more than you would pay for plywood alone.

Of hardwoods, for use where appearance is critical, Philippine mahogany is usually the least expensive by a wide margin. Shop for the prepackaged kind now sold in nominal 1″ thickness and assorted widths up to 12″. The pin-mark grade with its tiny worm holes is a good buy. You may prefer its appearance and you will surely like its lower price.

Where shelves are to span long distances or carry heavy loads, don't over-

Continued

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How long should a shelf be?

The distance a shelf can span without sagging noticeably depends mostly on its material and thickness—and the weight of the load.

Research done at the University of Illinois has produced some useful rules-of-thumb for spans:

- With ⅜" plywood, limit spans to 26" for normal loads, 16" for heavy loads; with ¾" plywood, 46" and 29".
- Solid wood ¾" thick can safely hold normal loads on a 48" span, heavy loads on 30". With lumber 1⅛" thick, spans may increase to 66" and 42".

Books and records are typical "heavy" loads, while clothing, toys, and most dishes will be "normal."

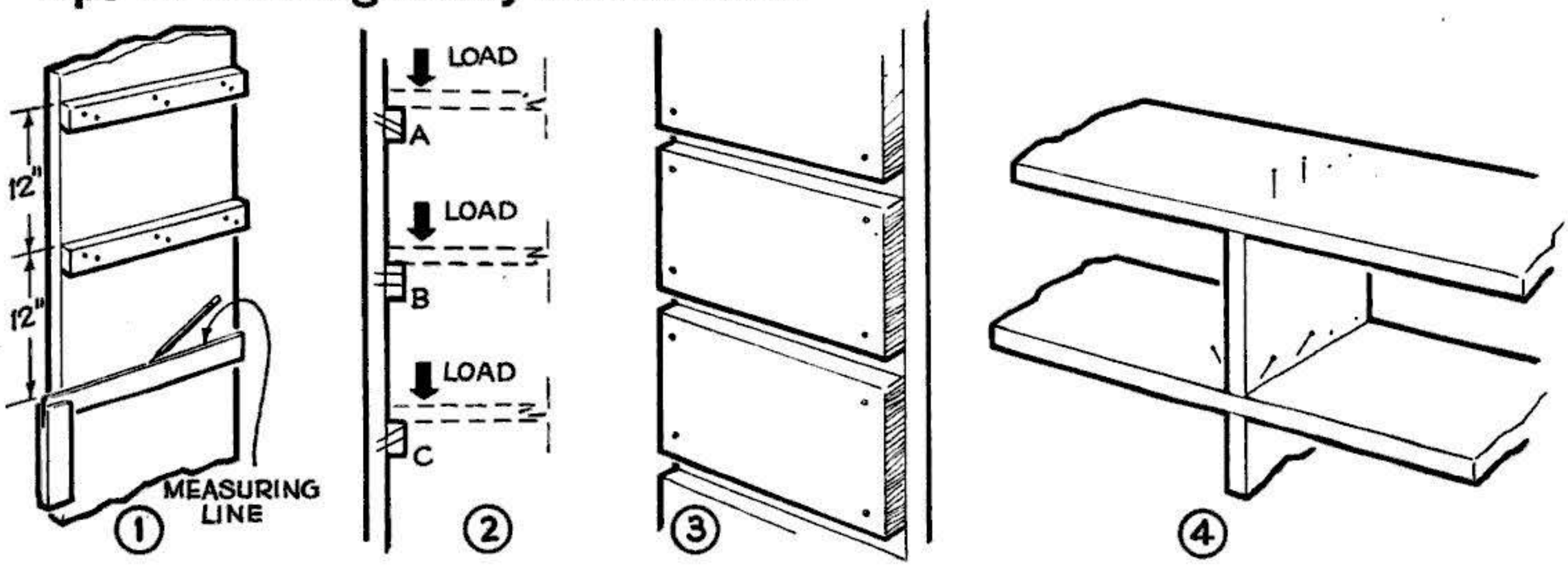
The table below provides more detailed information for planning shelves to be made of nominal 1" or 2" lumber, or plywood in any of the usual thicknesses. It applies to lumber having no knots wider than half the width of the board, and to plywood used so the face grain runs in the direction of the span—the usual practice.

The figures given are the weights, in pounds per square foot, that each combination of span and material will support without sagging more than 1/240 of the span (1/20" for each foot of length). Thus ¾" pine lumber used for a 36" span is acceptable for any load up to 38 pounds per square foot.

If greater spans are required, central support is necessary—whether of the type shown in the sketch, bottom right, or a wall bracket.

Distance Between Supports	TYPE OF SHELVING—ACTUAL THICKNESS							
	Pine and Cedar Lumber		Douglas Fir and Larch Lumber		Douglas Fir Plywood			
	¾"	1½"	¾"	1½"	⅜"	½"	⅝"	¾"
12"	670 lb.	2,685 lb.	1,134 lb.	4,537 lb.	163 lb.	330 lb.	593 lb.	817 lb.
16"	377 lb.	1,510 lb.	638 lb.	2,552 lb.	68 lb.	138 lb.	249 lb.	374 lb.
20"	222 lb.	967 lb.	356 lb.	1,633 lb.	35 lb.	71 lb.	127 lb.	191 lb.
24"	129 lb.	667 lb.	206 lb.	1,126 lb.	20 lb.	41 lb.	75 lb.	111 lb.
32"	54 lb.	378 lb.	87 lb.	638 lb.	9 lb.	17 lb.	30 lb.	46 lb.
36"	38 lb.	306 lb.	61 lb.	489 lb.	6 lb.	12 lb.	22 lb.	33 lb.
40"	28 lb.	223 lb.	44 lb.	356 lb.	4 lb.	9 lb.	16 lb.	24 lb.
48"	16 lb.	130 lb.	26 lb.	206 lb.	2 lb.	5 lb.	10 lb.	14 lb.
60"	8 lb.	66 lb.	13 lb.	106 lb.	—	—	—	7 lb.
72"	5 lb.	38 lb.	8 lb.	61 lb.	—	—	—	—

Tips for building sturdy fixed shelves



Merely butting shelves between uprights is seldom satisfactory; nails big enough for adequate support may split the shelving, and screws may not hold in end grain. Where dadoing is a problem, cleats do as well. Use square to establish cleat lines (Sketch 1) and stagger nails to avoid splitting. Best nailing angle—especially when cleats aren't glued, too—is downward (2C). Both A and B angles let cleats pull away from upright. Cleats of quarter-round or triangular stock are less conspicuous than ones shown, but even these become less noticeable if ends are beveled or set in from edge of upright. Or use cleats the full height of your shelf spacing (3), if double thickness of upright is not objectionable. Shelves too long for their load need intermediate support. If you don't have power tools to cut dadoes, you can nail in supports (4). Where these must align, you'll have to toenail the bottom edge in place.

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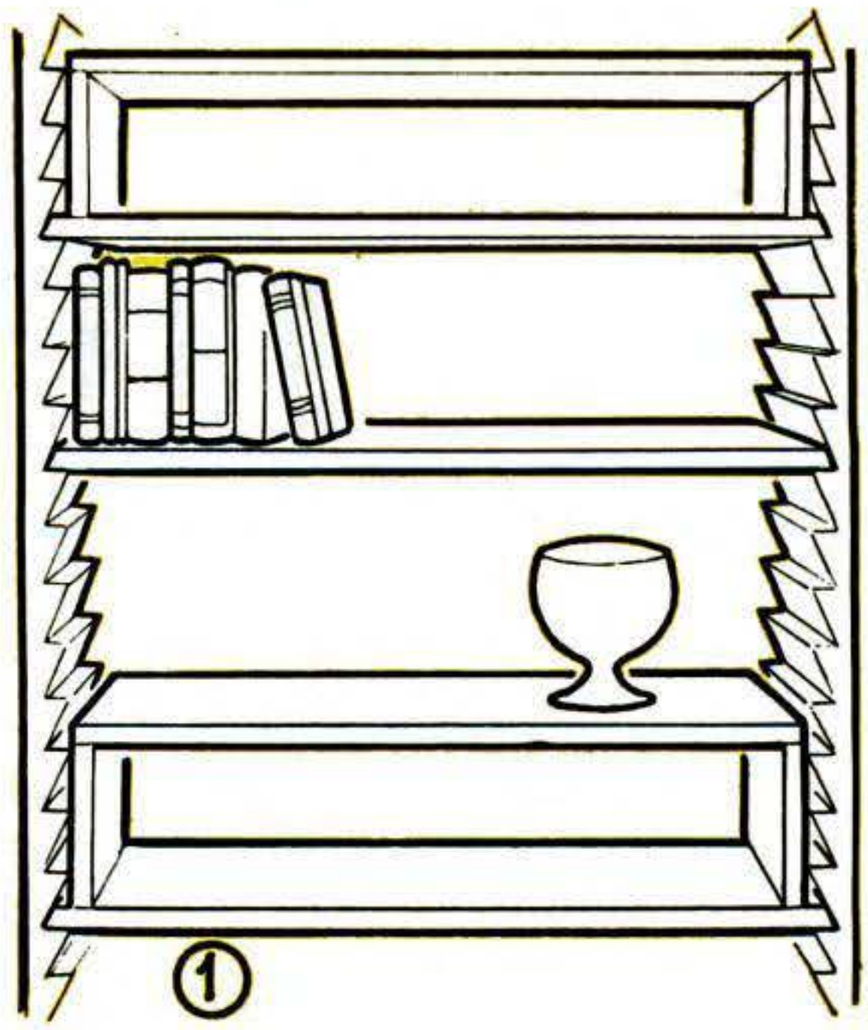

7 ways to make bookcase shelves adjustable

Face uprights with pregrooved plywood called Texture 1-11, as in photo. Another version (Sketch 1): beveled siding, mounted upside down to form series of ledges, with shelf ends (or projecting bottoms of box units) beveled to match. Sketch 2: adjustability through series of holes drilled part way through uprights. Metal angles with studs to fit holes may be bought, or short lengths of dowel substituted. Or cut series of kerfs across face of upright to take ¼" hardboard splines (3). Slotted metal standards with support clips (4) may be surface-mounted or set flush in grooves. Or drill holes down center of strip, then rip it to form pair of notched standards (5) for shelves with rounded ends. Similar method (6) is to cut series of V notches across strip with 90- and 45-degree saw settings, then rip into pairs. These standards leave gaps at shelf ends, unless you use support sticks between standards and notch loose hardboard shelf at corners. Easiest method of all uses Pegboard on uprights and four hooks per shelf (7).

look the advantages of thicker lumber. Its extra cost may be balanced by the saving on intermediate support. It will give you a bonus in appearance as well as in providing long, unbroken areas for storing away large or bulky equipment.

Suitable stock for wide, thick shelves is not easy to find at moderate price. A good way around this problem is the use of tongue-and-groove Ponderosa pine,

How to hang shelves on masonry walls

Hollow masonry, such as cinder block, calls for fasteners that open up in the hidden core. To install Molly type, above, anchor fastener in wall, then remove bolt and insert it through back of shelf unit.

Solid masonry can either be drilled for shield-type bolt that expands in hole, or plate-type bolt can be fastened to surface with mastic, as above. Sound, noncrumbly surface is required for this treatment.

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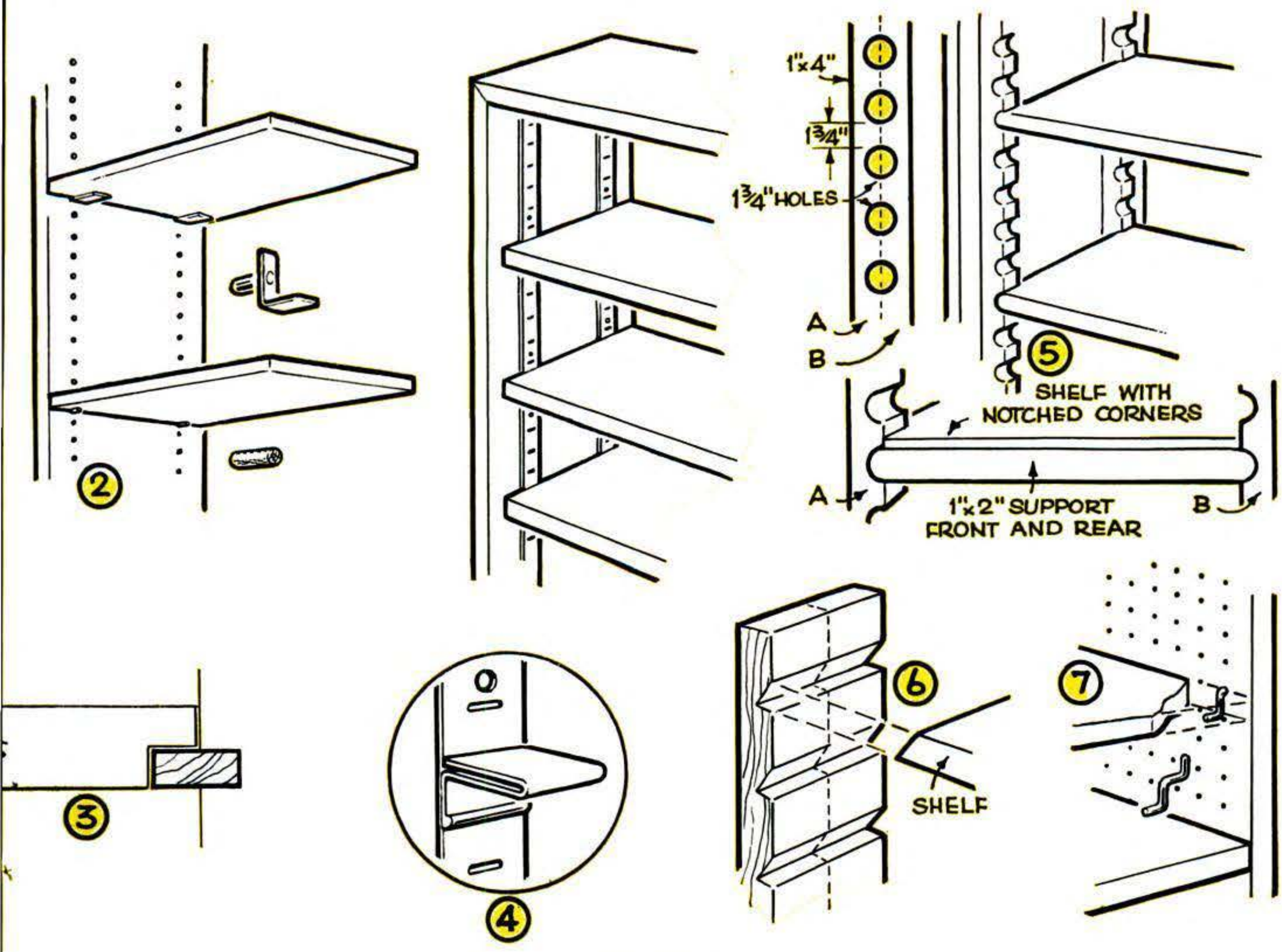
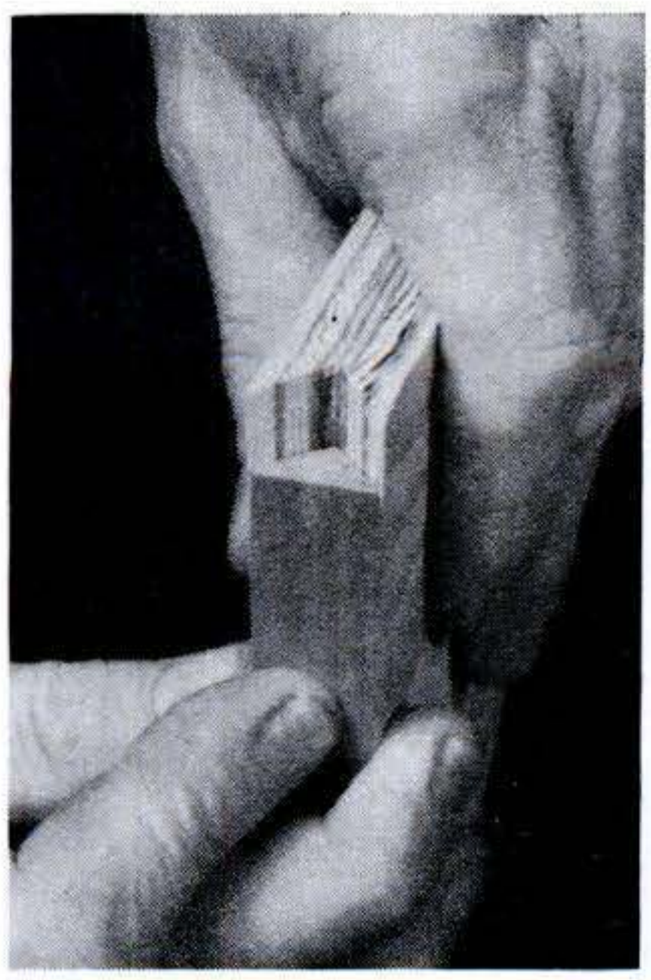


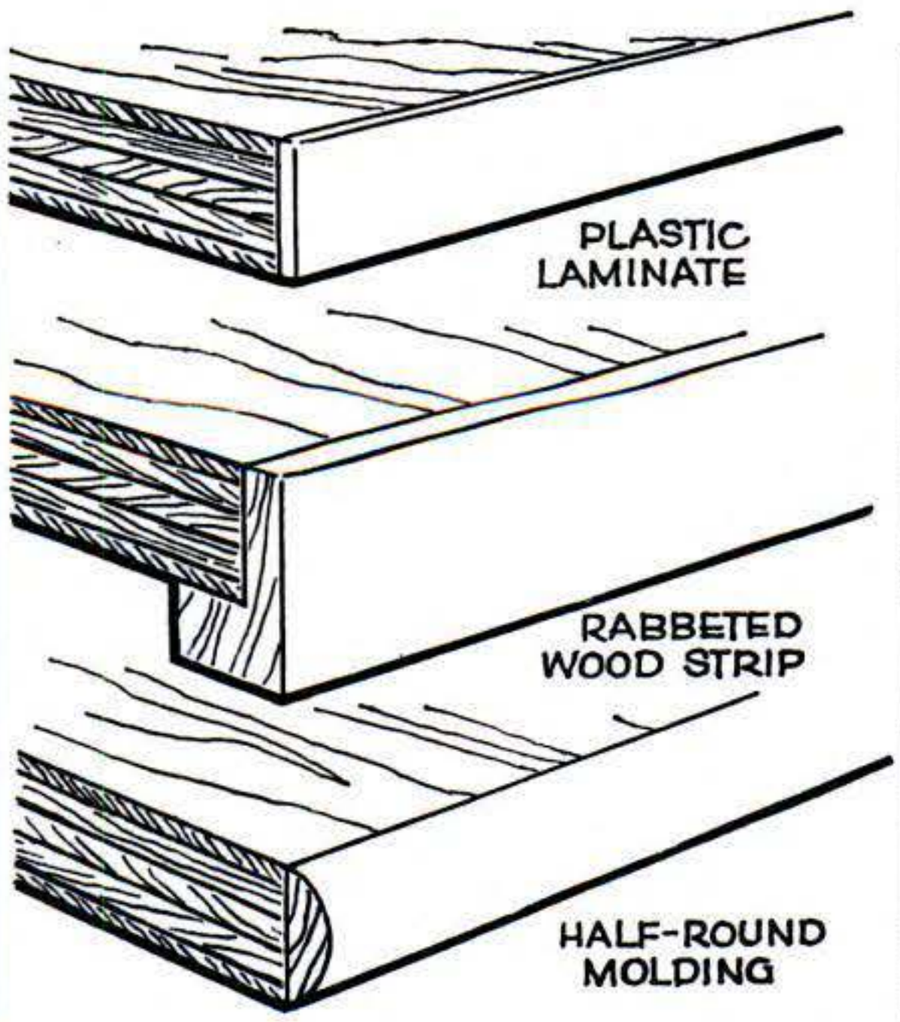
sold kiln-dried in such dimensions as 2″ by 6″ and 2″ by 8″. Because it is a commonly used construction material, it may be priced far below an equal amount of other suitable lumber. Put the groove at the shelf back, where it won't show, and finish the front by planing off the tongue of the final piece.

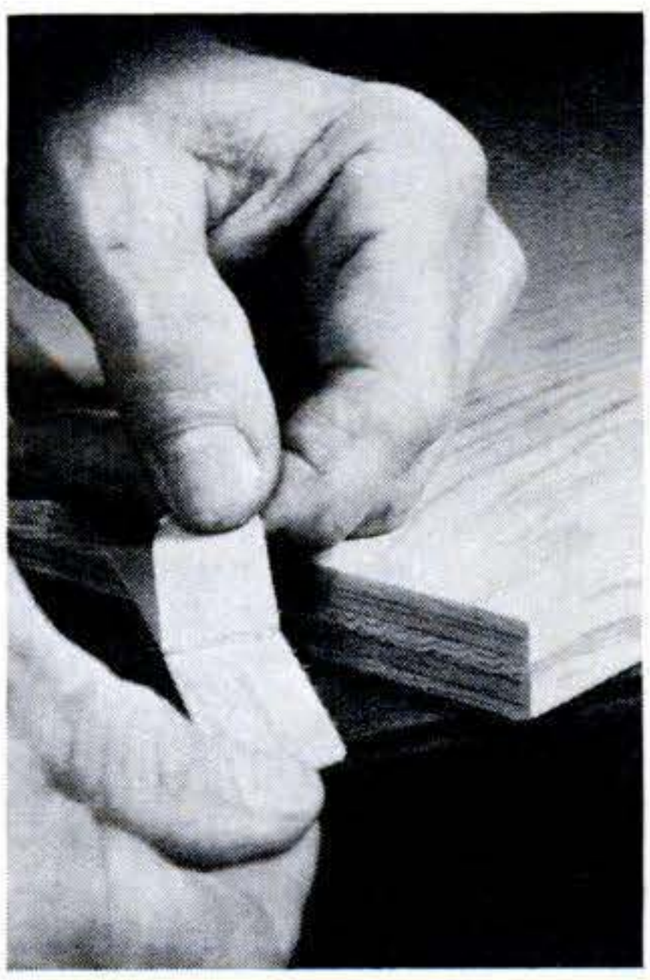
Hollow-core slab doors of Philippine mahogany, handsome and inexpensive,

Continued

How to edge plywood shelves







Exposed plies at front of shelves are unsightly and invite splintering. If shelves are to be painted, fill voids with wood putty and sand smooth. For natural finish on hardwood plywood, edge treatment ranges from V notch with triangular strip of matching wood (left) through plastic laminate, rabbeted strip to beef up thickness, and half-round molding (center sketches) to self-sticking strips of veneer (right).

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make wide, thick shelves of surprising lightness and strength. They're limited, of course, to situations where you can use standard dimensions — widths usually from 18″ up, length 80″.

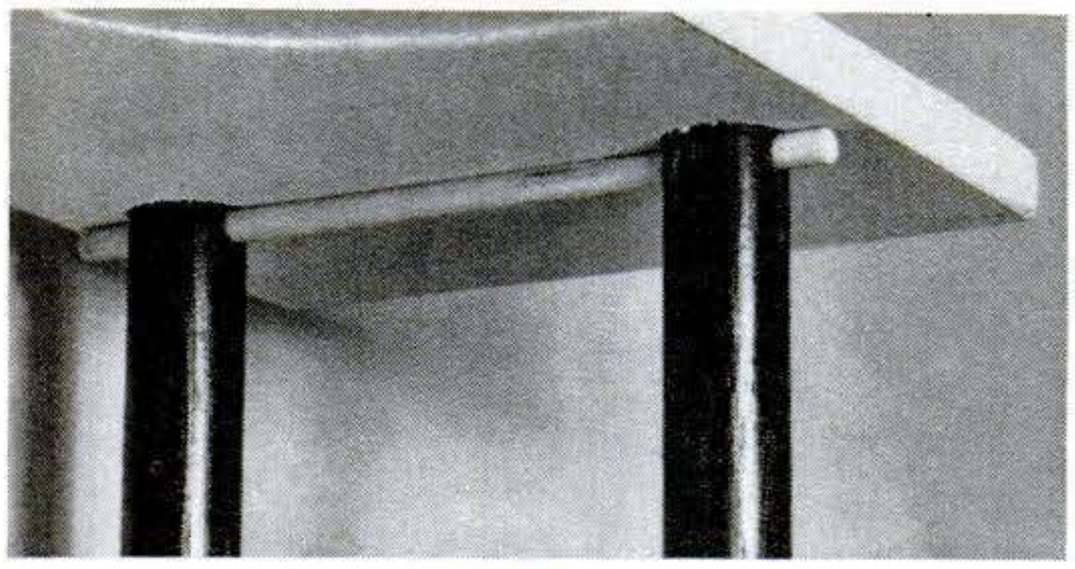
The need to match the surroundings will often dictate your choice of finish. Where you can choose freely, an easy alternative to the traditional stain and varnish is a single coat of stain wax. This comes in a variety of gray, neutral, and wood tones and pastel shades. Apply it with a brush or rag, let it soak in for a few minutes, then rub it off and polish with a lintless cloth. PS

Dadoes may give all the support shelves need

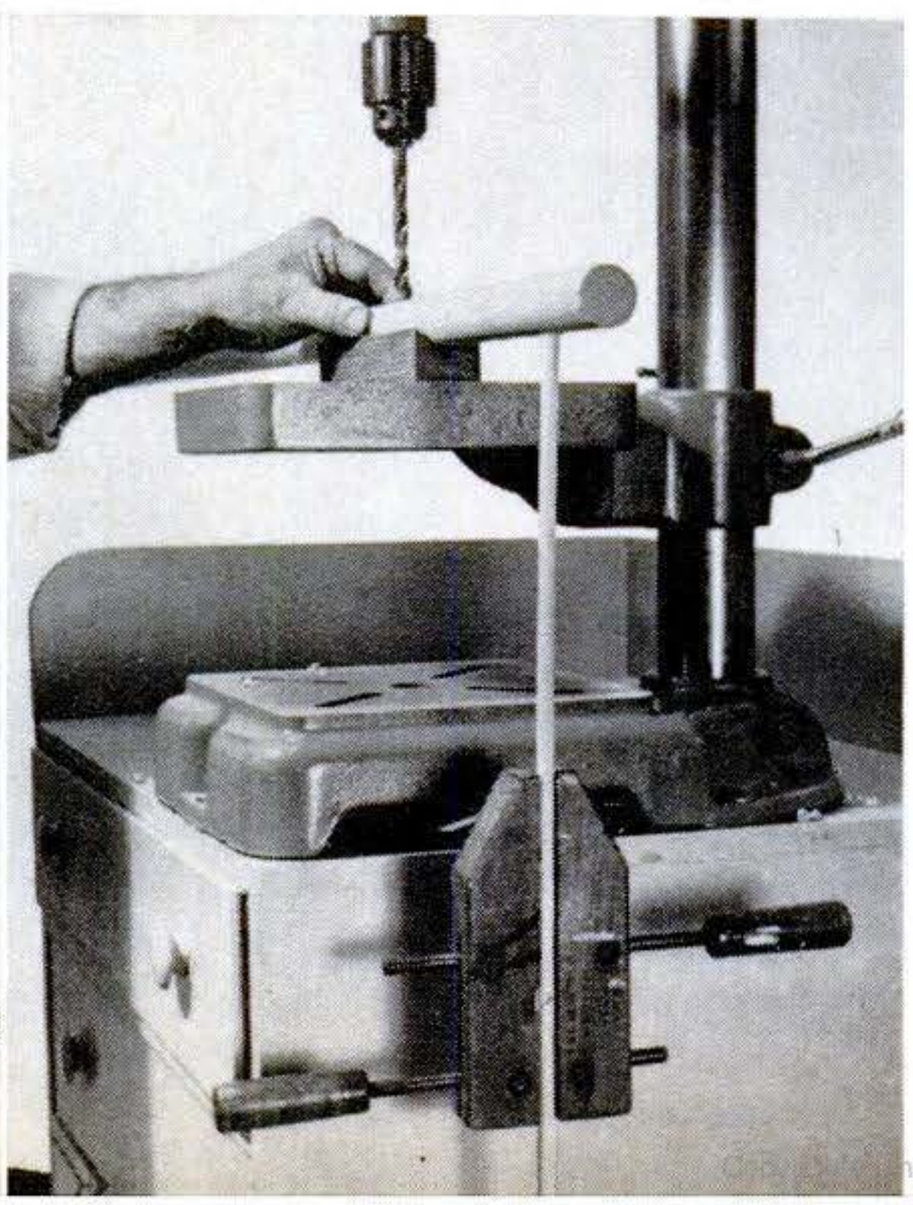
Simplest way to support shelves is to slip them into dadoes cut in firmly anchored uprights. For infinite adjustability, provide a series of dadoes and leave shelves loose, as at left. Here, dadoing was done across wide hardwood stock which was ripped into uprights 1¾″ square. At right, fixed one-by-four shelves make use of space between two-by-four studs—just cut dado across studs when you're erecting single-face partitions.

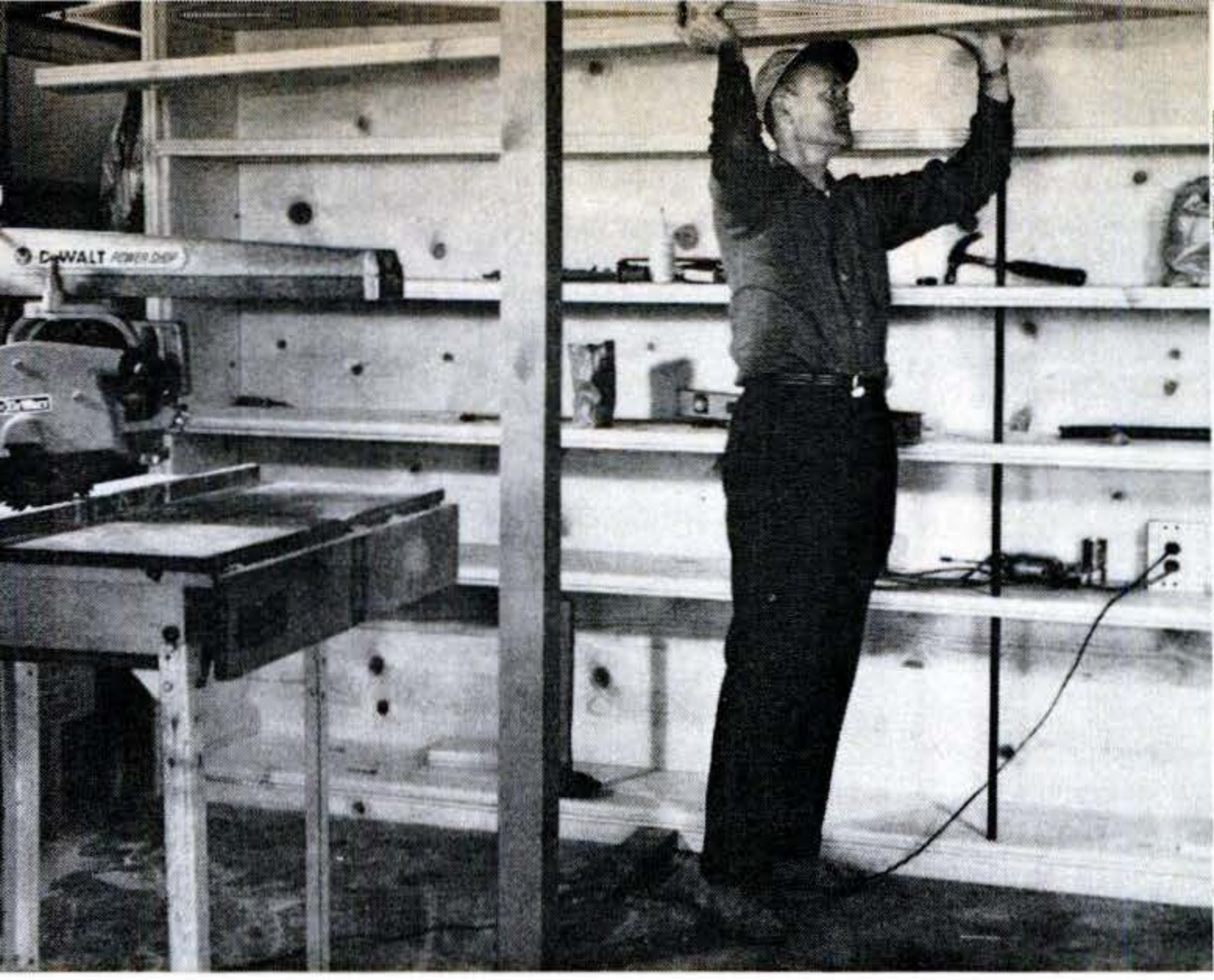
Ladder of dowels supports shelves for adjustable take-apart unit

No fastening of any kind—no nails, screws, or glue—is used in this bookcase assembly. You can tailor shelf spacing to present needs, then change the arrangement for future needs. Unlike most commercial supports, this system doesn't require drilling holes in walls. The whole unit knocks down in minutes to be moved to another room—or to another house.



The uprights are wooden closet poles that pass through the pine shelves, which are held in position by ⅜″ supporting dowels inserted through the poles, as at left. The trick shown below keeps the holes for these rungs aligned: Set pole in V block, drill snug hole, and insert dowel with heavy clamp attached for plumb-bob effect. Weight prevents any twisting as other holes are drilled. You can drill only holes needed for desired arrangement, or space them at 2″ intervals for more flexibility. Stack one-by-10 shelves and drill pole holes through corners with expansion bit. After painting, drop one shelf at a time onto poles, inserting support dowels.





Pine decking and pipe create utility shelving

Tongue-and-groove Ponderosa pine decking makes long, wide, husky shelves for heavy-duty storage in basement or at rear wall of garage. Nominal 2″ lumber permits long spans. Vertical 1″ boards set between shelves give support along back edges, while at front short lengths of water pipe are slipped between shelves (right photo) to fit in shallow holes drilled before assembly. Without solid center supports, the full length of each shelf is available for storing long items—such as lumber or pipe.

Inefficient closet shelving robs you of your best potential storage space

A single shelf above the clothes rod is all most closets offer. Piling items on this shelf, as at right, makes poor use of space. Photos below show how egg-crate inserts, tailored to size of items to be stored, solve various problems in identical closets. Shelving at lower right organizes space below bar, as well, where only part of closet is used for clothes. Full-depth bottom unit goes to floor, has compartments for grocery cart, table leaves, vacuum cleaner, plus bin with hinged front for rags. Feature of shallower upper unit is built-in wine rack of scalloped hardwood strips notched into uprights and drilled for 1″ dowels. Slots formed by end-wall cleat store reference books on wine. Depth of upper shelves can be increased as in center photo.

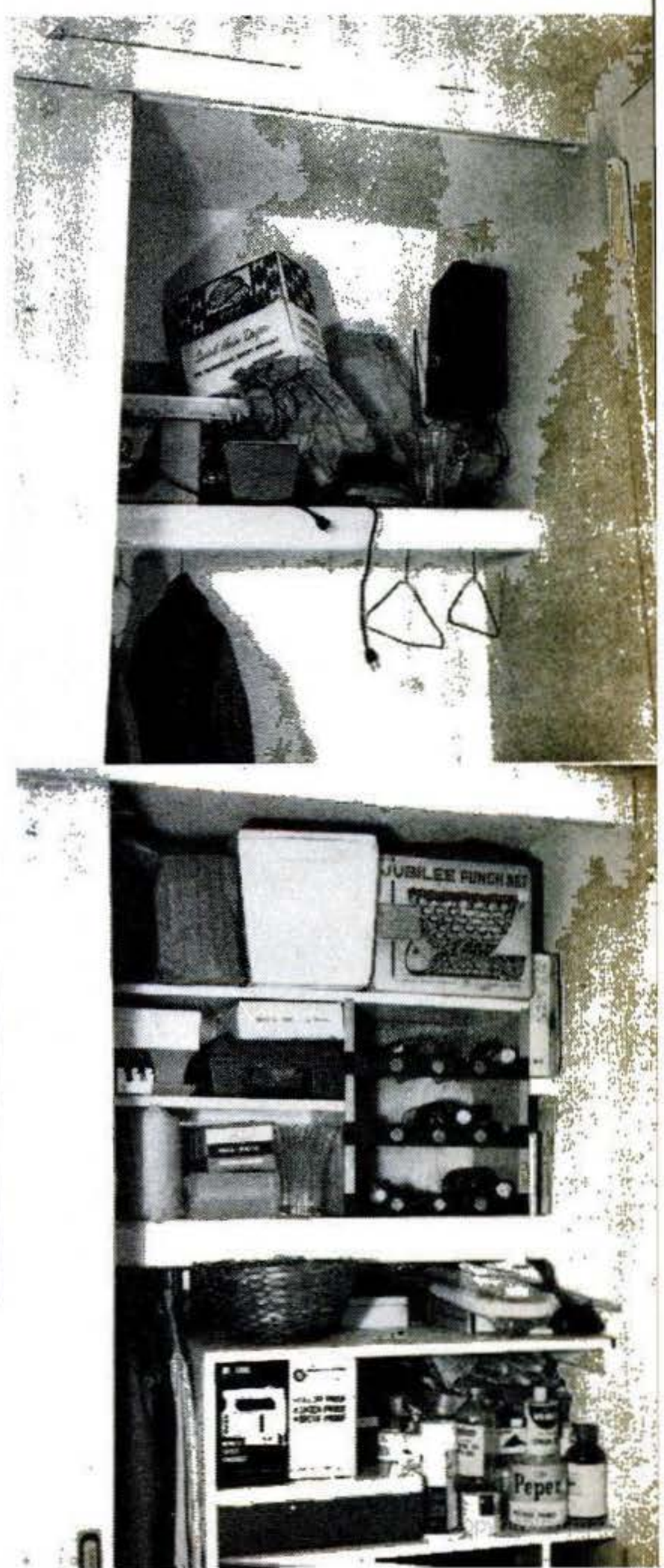


Photo supplies (left) store in customized cubbyholes. Camping gear (right) tucks against ceiling. Units are of ¾″ plywood with removable ¼″ dividers.

Standards are boldly emphasized in Masonite's new walnut-finished system, which recesses them in carved solid-wood pilasters 52 inches long. Matching brackets hook into slots (above) to support prefinished shelves with molded edge, in various lengths. Masonite Corp., 29 N. Wacker Dr., Chicago 60606.

Widest Choice Ever in Shelving Systems

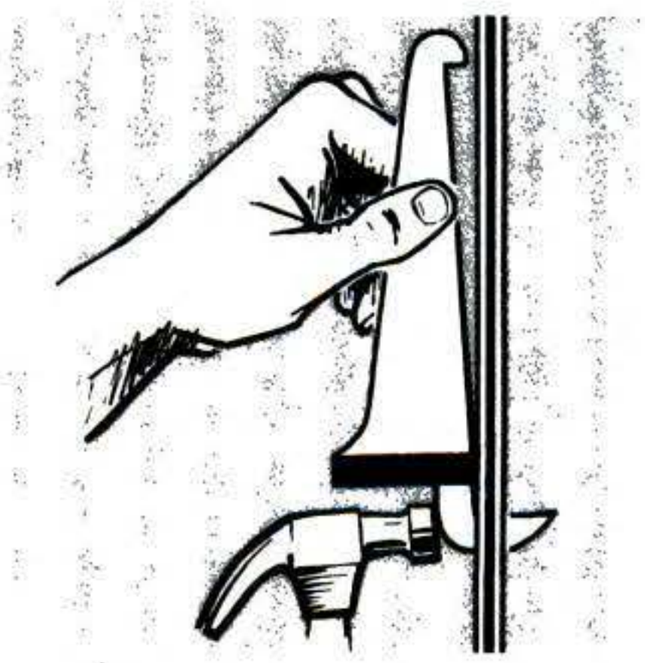
The fastest means of adding display shelving is a commercial system that suspends shelves from a wall. A common type consists of slotted metal uprights (standards) fastened with screws into studs (or with expansion fasteners or toggle bolts on hollow walls), plus metal brackets that hook into the slots.

If you object to naked metal, the products shown here offer novel solutions. You can choose a system that eliminates standards altogether, or one that utilizes them as a design element. Another system conceals the brackets by tucking them inside the shelves themselves.

In each case, shelf spacing is adjustable.

PS **SHELVING**

Brackets without standards come with pointed hook that drives through face of hollow wall. When bracket is pivoted horizontal, hook seats against back of wall, will support 20 pounds in drywall or 30 in ¼-to-⅝-inch plywood. Tap-N-Hold comes in three sizes: Timber Engineering, 1619 Mass. Ave. NW, Washington, D.C. 20036.



Not a mark on the wall with the new inside-out suspension system seen at center, above. Tension poles, wedged between floor and ceiling, put hidden standards at front of shelves. At upper right, a complementary pillar system is screwed to wall. Both systems: Flaire Phase II, soon available from Stanley Works, New Britain, Conn. 06050.

Bracketless shelves hook into steel standards covered with walnut-grain vinyl for a system in which no metal shows. Shelves come in four lengths (24 to 72 inches), in widths of eight, 10, and 12 inches, with sturdy brackets hidden inside. It's Wall Furniture, by Hirsh Mfg. Co., 8051 Central Park Ave., Skokie, Ill. 60076.

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Adjustable Shelf System for a Show-Off Wall

You slice shelves and uprights from plywood, assemble with novel splines, homemade brackets

By GEORGE S. KANELBA, A.I.A.

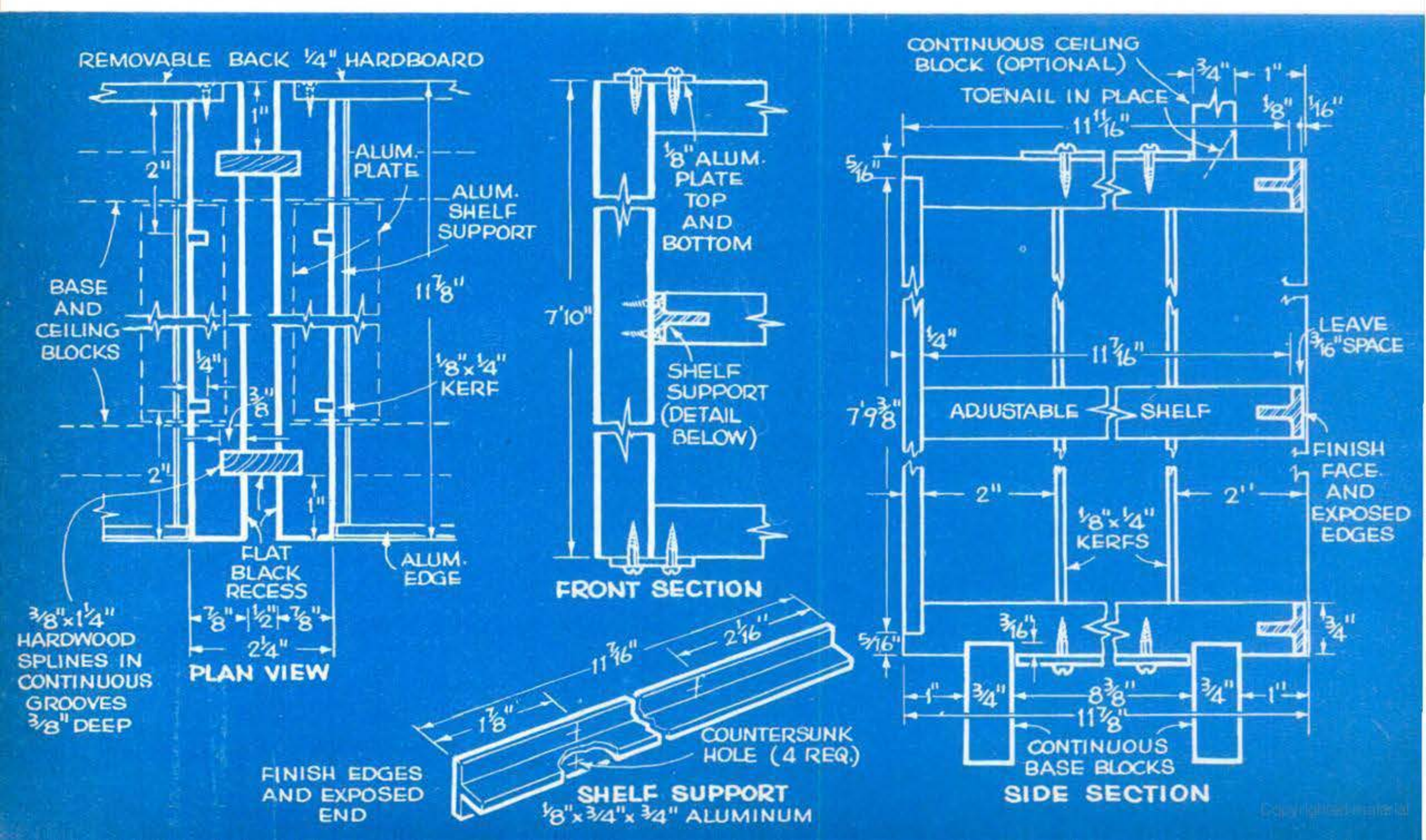
Most adjustable wall systems are expensively overengineered. They provide an unlimited flexibility in the arrangement of shelves, but this is rarely needed. Once the average home owner has tailored the arrangement of shelves and cabinets to the needs of his own books and display objects, he rarely needs to alter it.

So I designed a system that permits adjustment without marring any surfaces, but uses economical materials. A series of compartment units is constructed, of varying or identical widths, to fill available wall space. These are locked together with vertical splines, recessed from the front edge to create a neat "shadow-line" joint that avoids the need for perfect butting.

I had a 16′-long living-room wall, which I divided into six sections. Starting with 1′8″ as the narrowest desirable compartment, I then added 4″ increments to each succeeding compartment: 1′8″, 2′, 2′4″, 2′8″, 3′, and 3′4″. Allowing for a ½″ gap between all units, I ended up with a total width of 15′2½″, which left space at either end for a filler strip to close the gap at the side walls—always a wise allowance, since walls are never plumb.

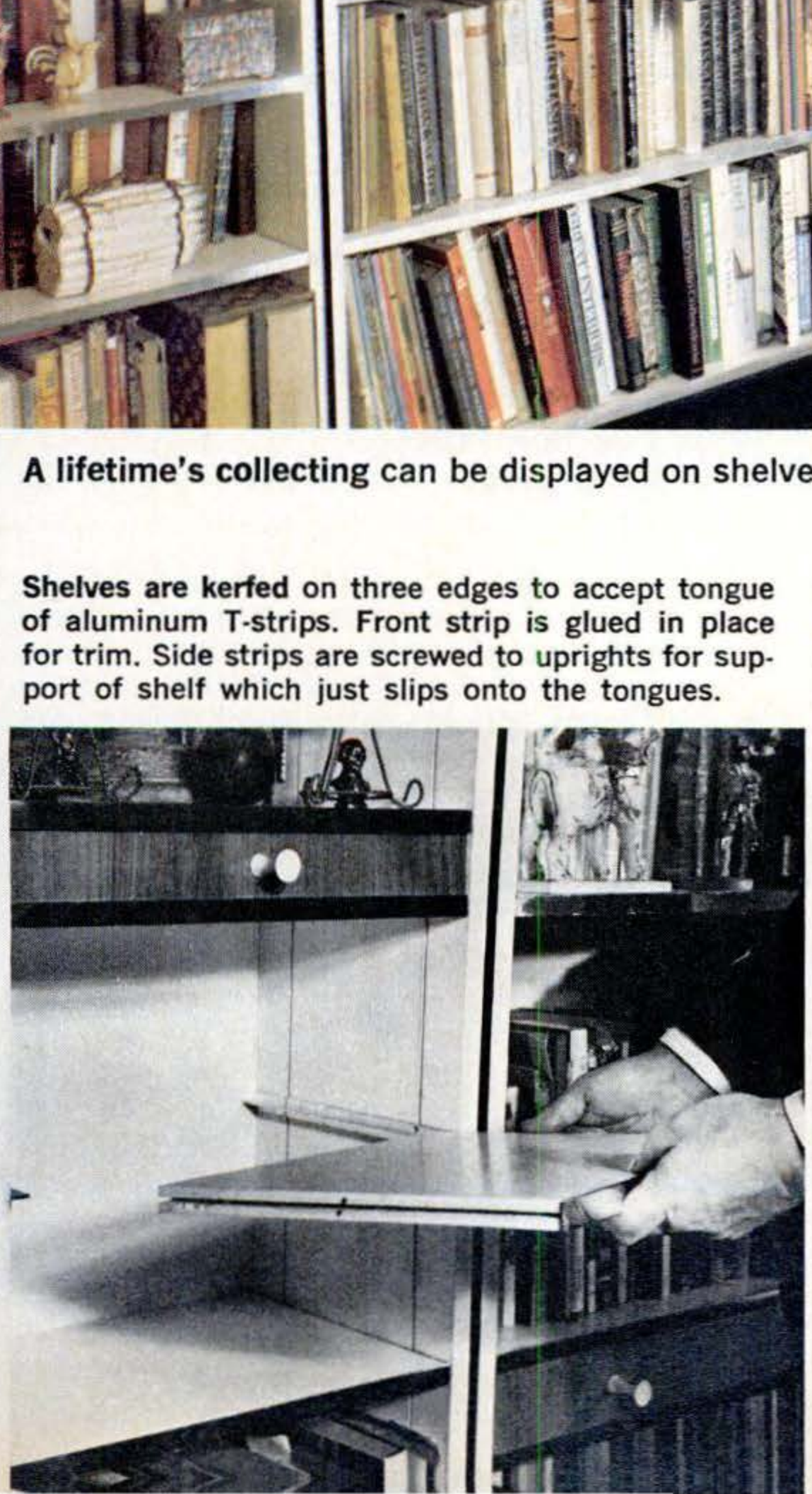
I recommend a compartment height of no more than 7′10″, since this allows raising units above the floor on recessed

[Continued on page 225]

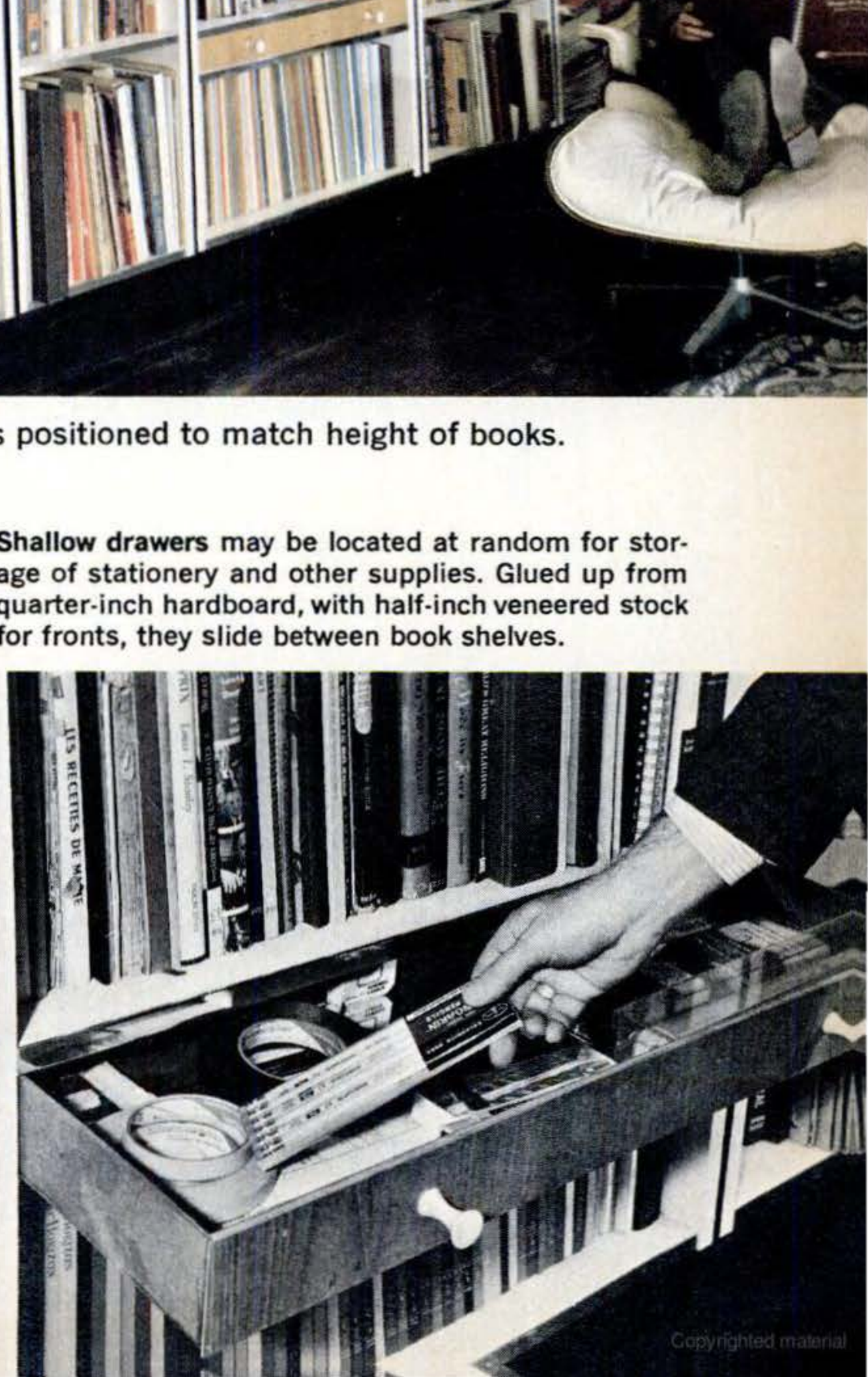


A lifetime's collecting can be displayed on shelves positioned to match height of books.

Shelves are kerfed on three edges to accept tongue of aluminum T-strips. Front strip is glued in place for trim. Side strips are screwed to uprights for support of shelf which just slips onto the tongues.



Shallow drawers may be located at random for storage of stationery and other supplies. Glued up from quarter-inch hardboard, with half-inch veneered stock for fronts, they slide between book shelves.



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No Attic?

By FRANK GREENWALD

Shelf system of pine and tempered hardboard is modular in construction—it can be easily disassembled and moved, and new sections can be added. Each shelf of this 84-cu.-ft unit holds 300 pounds.

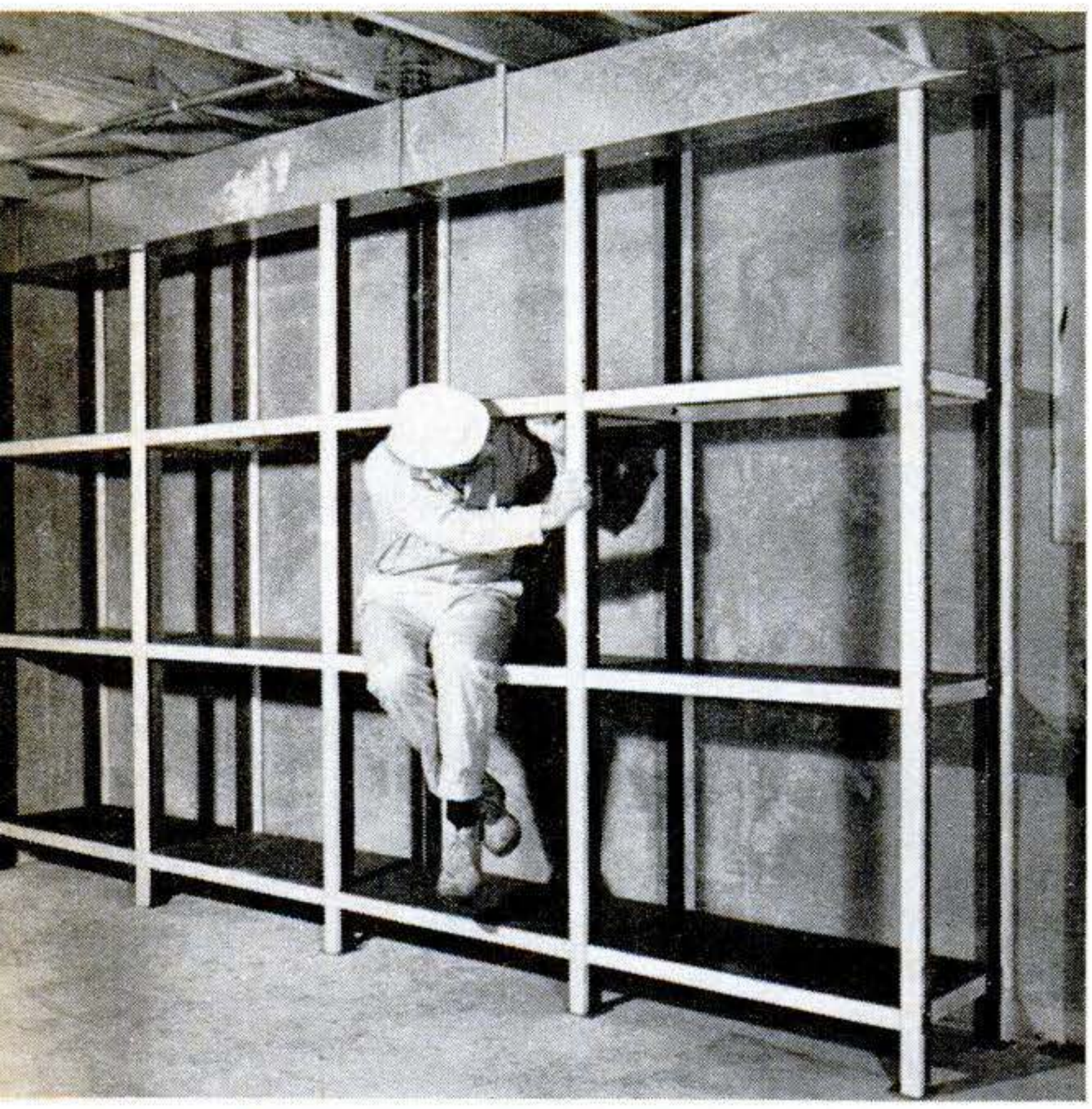
Modern architecture gives us a new approach to an old idea—building large shelves in a basement to store bulky items usually stacked in an attic. Called the module concept, it means that a structure of any size can be built based on a small basic unit, or module. Once you have this, you can add as many identical units as you need. Applying this concept, I built shelves that are easy to take apart, move, and enlarge—all from two types of material cut to very few different sizes.

The only materials you'll need are 12′ lengths of one-inch pine board—preferably knotfree—and ⅛″ tempered hardboard. Rip the pine into 1½″ strips. You'll cut all pieces—shelf frames and posts—from this one size. Assemble the frames with glue, securing them with six-penny finishing nails. Use glue and brads to fasten the hardboard shelf top.

Post height depends on available head room. For uniformity, lay out one post, then use it for a pattern. Make sure the shelves fit tightly in the notches.

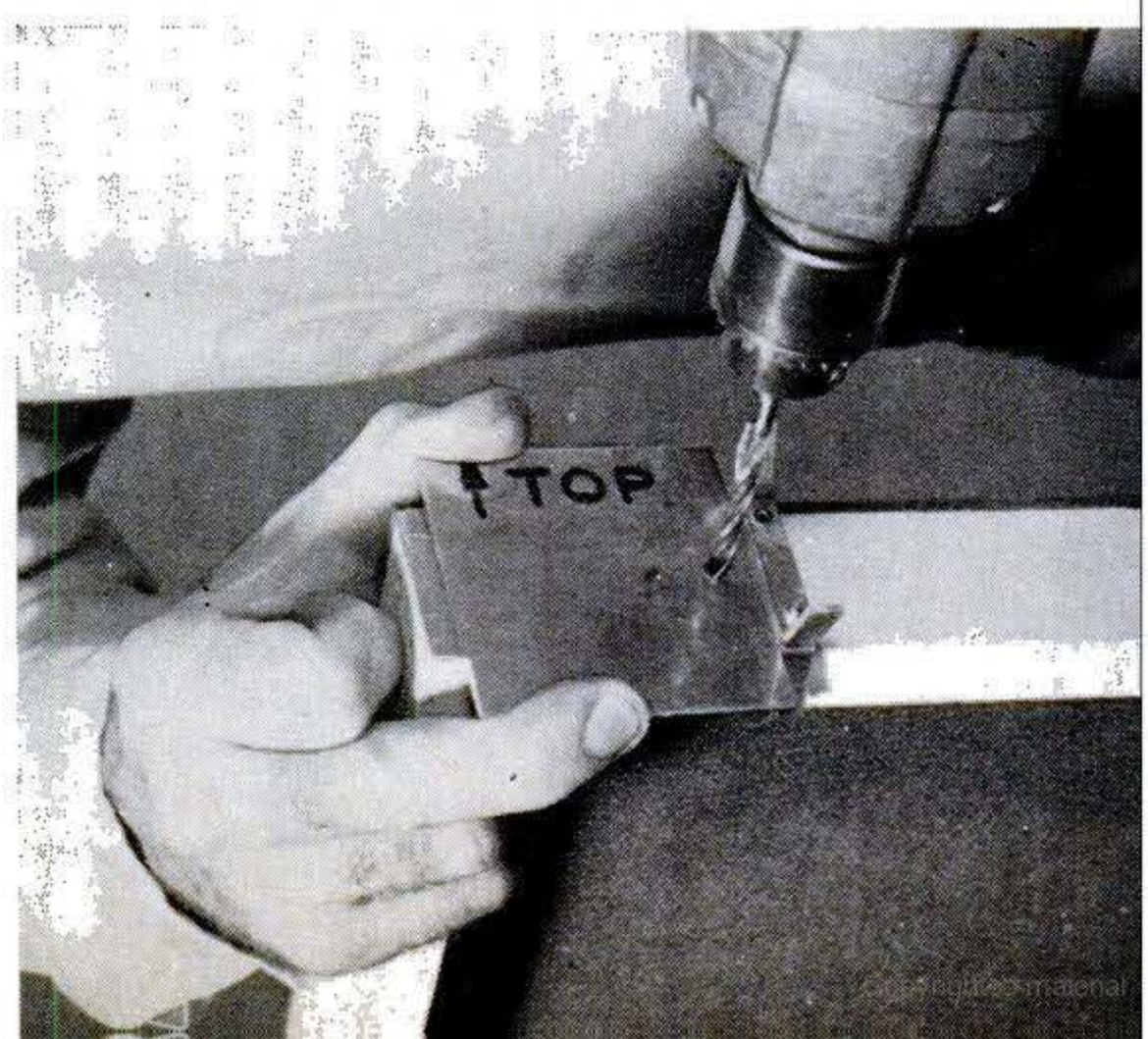
The hardboard flanges should be snug in the post grooves. They also are held with glue and brads.

If space permits, it's easier to bolt the finished unit together on its side.



Support posts and shelf sections are held together with stove bolts. This unit has shelves 16″ deep, 24″ high, but you can alter dimensions to suit your needs. Allow a 6″ space at the bottom.

Metal-drilling jig ensures uniform bolt-hole location. For drilling shelves (below), align the projecting tongue with corner. The two ears straddle the edges of shelf frame. Use the same jig for drilling hard-



Shelves Will Do the Job

3/16"-#24 TEE NUT - 2 REQ. PER SHELF IN ONE END ONLY

3/4"x1½" WOOD

⅛" TEMPERED HARDBOARD

5/8"-#18 BRADS SPACED 6"

32"

⅛" TEMPERED HARDBOARD

3/8" DIA.

3/4"

1½"

1¼"

15/8"

12"

13/16"

2½"

12"

ALTERNATE WIDTH 16"

3"

1¼"-#16 BRAD EVERY 8"

ALTERNATE SPACING 16" OR 24"

1¹⁄₁₆"

3"

1⅝"

1¹⁄₁₆"

¼"

3¼"

TOP

2½"

1½"

3/16" DIA.

1⅝"

MARK BOTH SIDES

BEND TAB TO APPROX 60°

STRIP ¼"x3". RIVET IN PLACE TO PROVIDE TABS BOTH SIDES

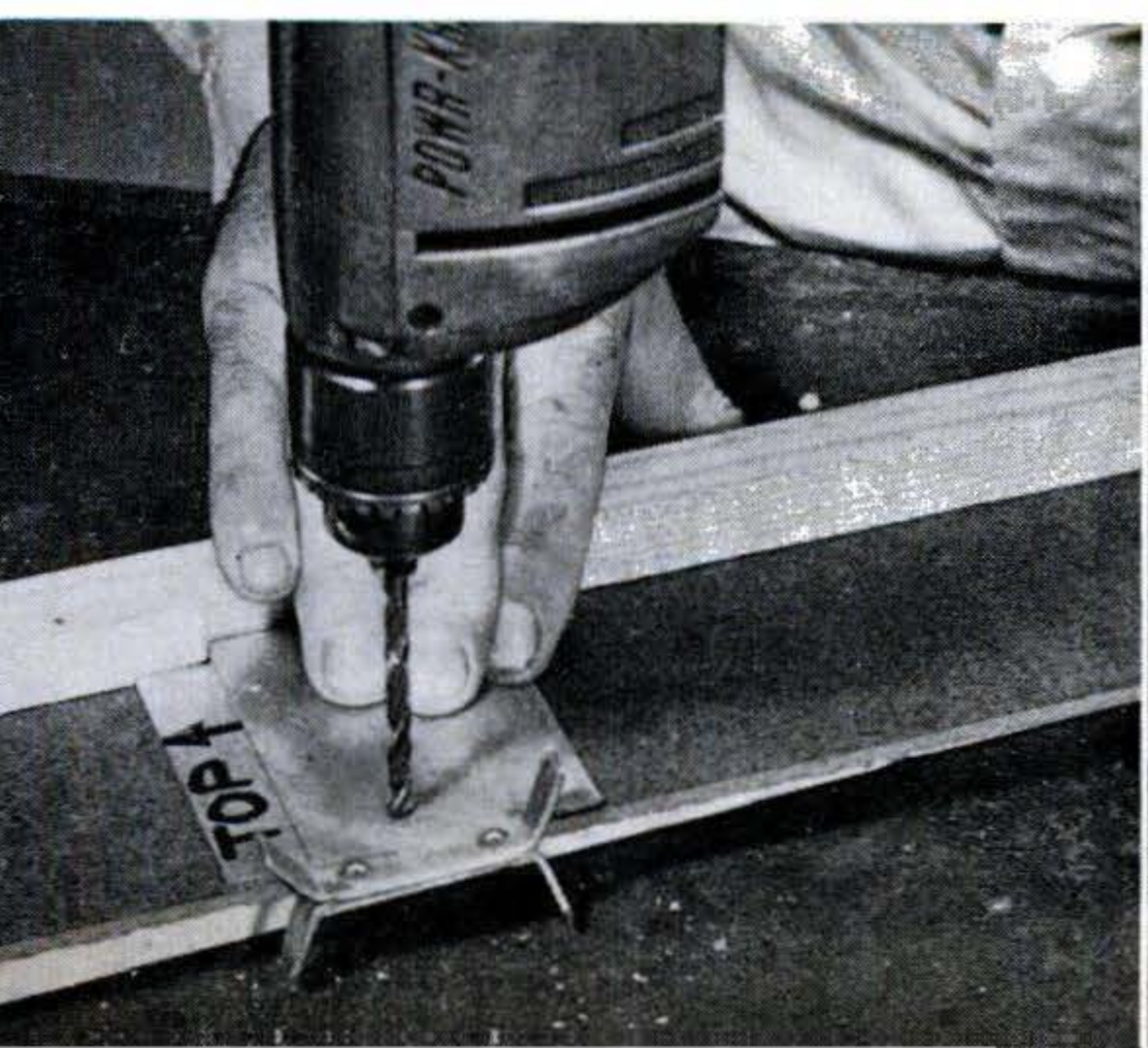
6d FINISHING NAIL. TWO AT EACH CORNER

1"-#8 WOOD SCREW. USE ONE AT EACH SHELF LEVEL IN OUTSIDE END SUPPORTS ONLY

DRILLING JIG 16-GAUGE (1/16") ALUMINUM OR STEEL

board post flanges with the tongue in shelf notch and the ears against the hardboard. "Top" notation, on both sides of the jig, shows its correct position for drilling both posts and shelves.

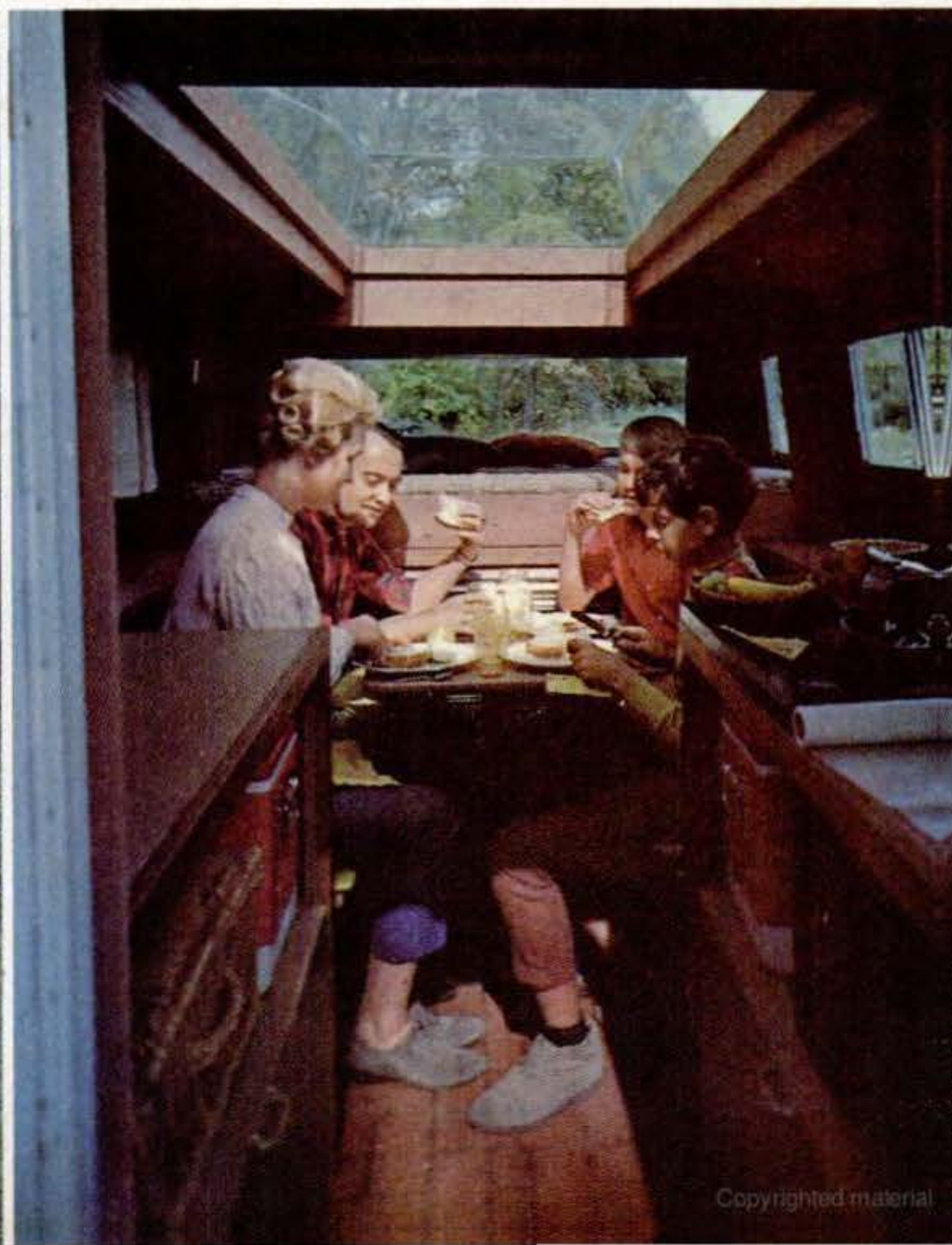
Final assembly requires only a screwdriver. Stove bolts and nuts fasten shelves to end posts; bolts and T nuts hold remaining shelves and posts. Reinforce end post joints with wood screws as in drawing.



At home in natural settings, this light but gutsy duo is ideal for off-highway wanderings.

As handsome going as it is coming, camper sits low enough to permit easy entry without step stool. The siding and metal corners echo color and trim of car.

Indoor dining has feel of outdoors with skylight and picture window. Phase-One camper lacks built-in kitchen facilities, but food coolers are within reach.



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Win Raves with a Redwood Camper

Build it for this summer from prefinished plywood—for use on Ford's car-type Ranchero pickup

By ROBERT MARTIN ENGELBRECHT, A.I.A.

For several years, my architectural firm in Princeton, N.J., has been involved in design-development and market-analysis programs for vacation homes. Our projects have ranged from a tent platform that grows into a permanent cabin, all the way up to a ski lodge that sleeps 20.

But my own family prefers a mobile vacation. Rather than settle in one spot each summer, my wife and two sons coax me into far-ranging wilderness rambles. And the more experience I've had of summer travel, the more I've developed a distaste for the discordant note that the American vacationer brings to our shrines of national beauty.

In articles and lectures, I've criticized the garish design concepts in many commercial recreational vehicles. Inevitably, I've been asked just what I'd prefer. Sev-

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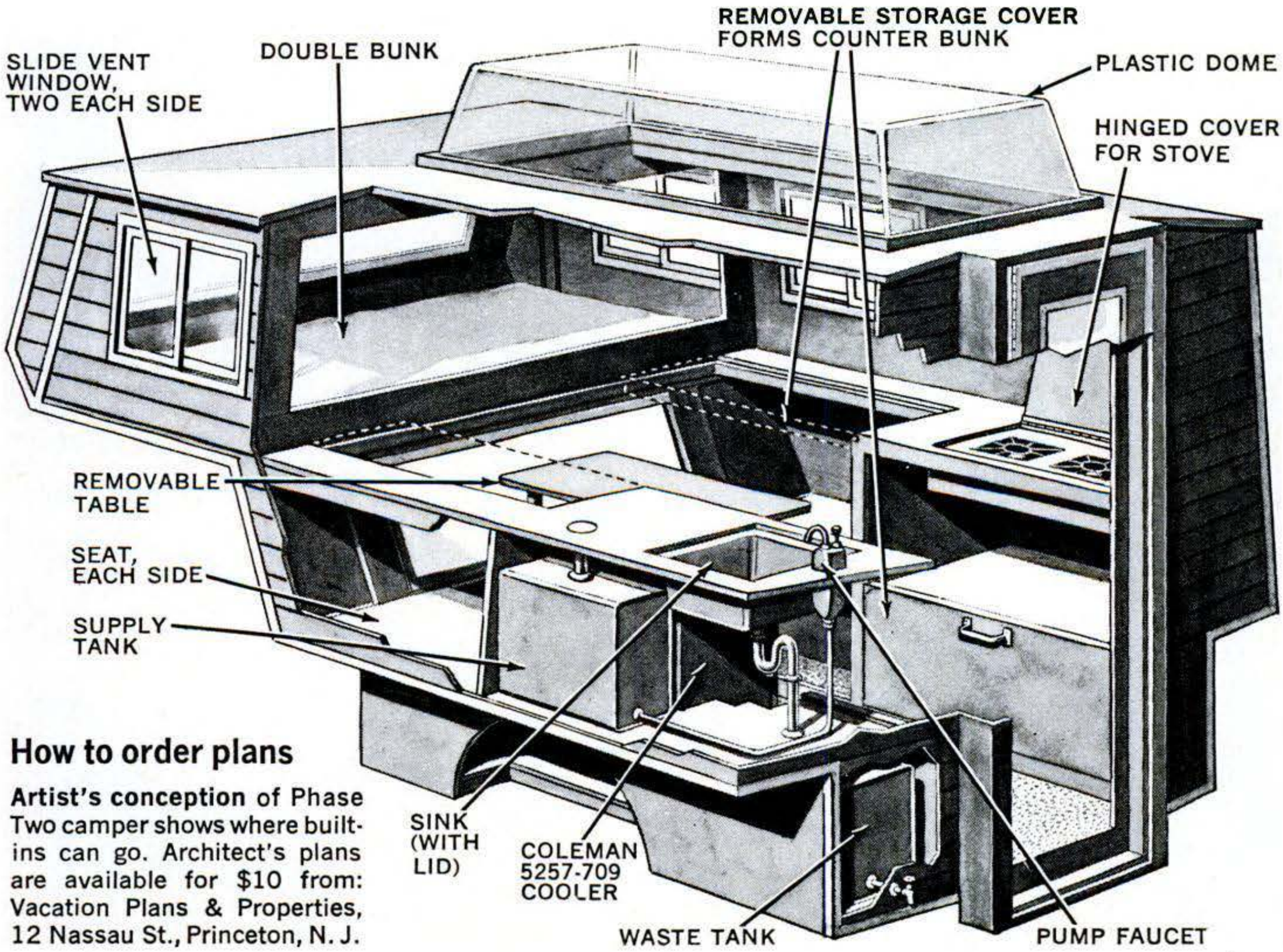

How to order plans

Artist's conception of Phase Two camper shows where built-ins can go. Architect's plans are available for $10 from: Vacation Plans & Properties, 12 Nassau St., Princeton, N. J.

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eral of my building-material clients challenged me to design a unit that would provide essential camping facilities without violating esthetic standards—a unit that anyone with average skills could build. More and more people, they pointed out, were already building their own vacation units—often with results more objectionable than the factory-produced models.

The only fair approach, I felt, was to design a camper that I (with the help of

Continued

Our architect-designer gave camper a cross-country family road test

Chicago tower, shot through dome, proves camper was as happy in city as at Rushmore (right).

Neither cows nor canyons of Wyoming slowed camper for long—or gave it an alien appearance.

Baking in the Badlands or waiting for Old Faithful at Yellowstone (right), camper kept its cool.

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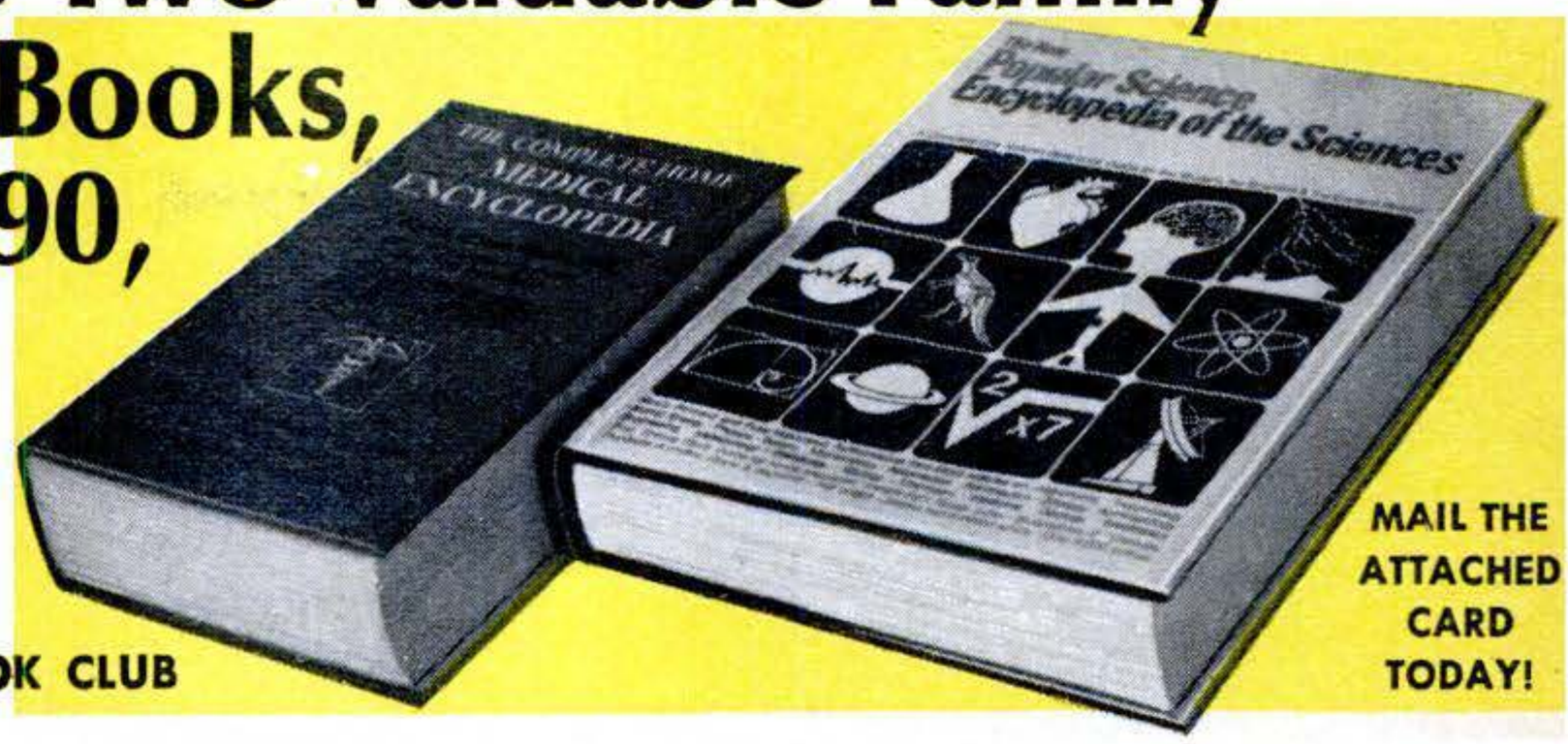

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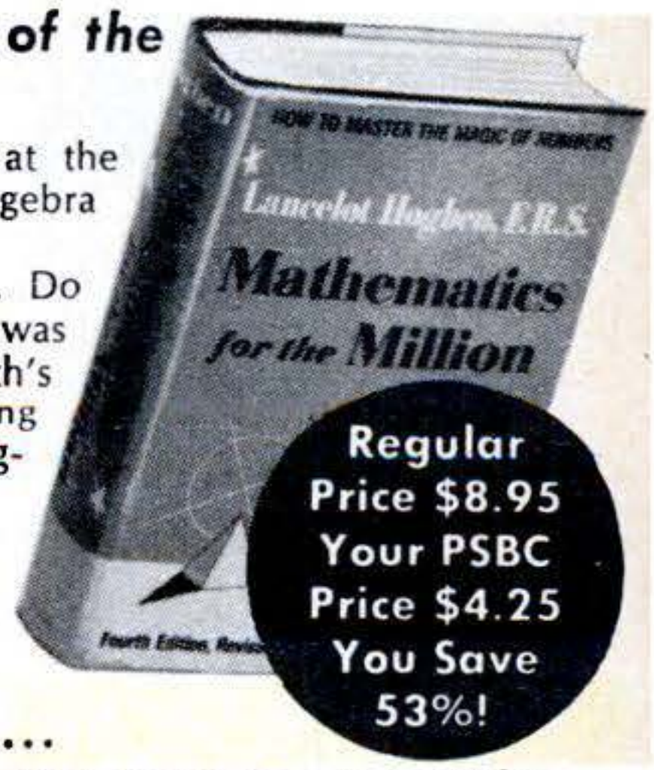

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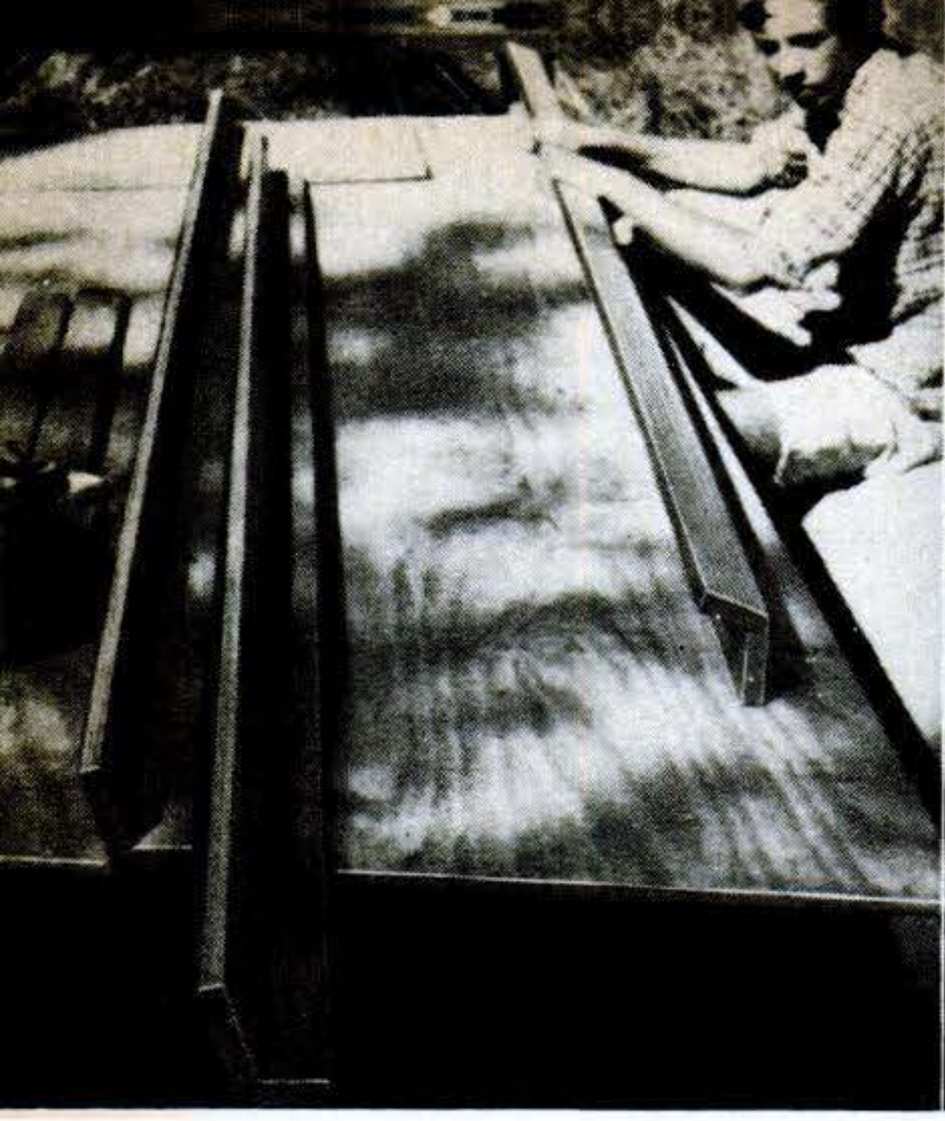
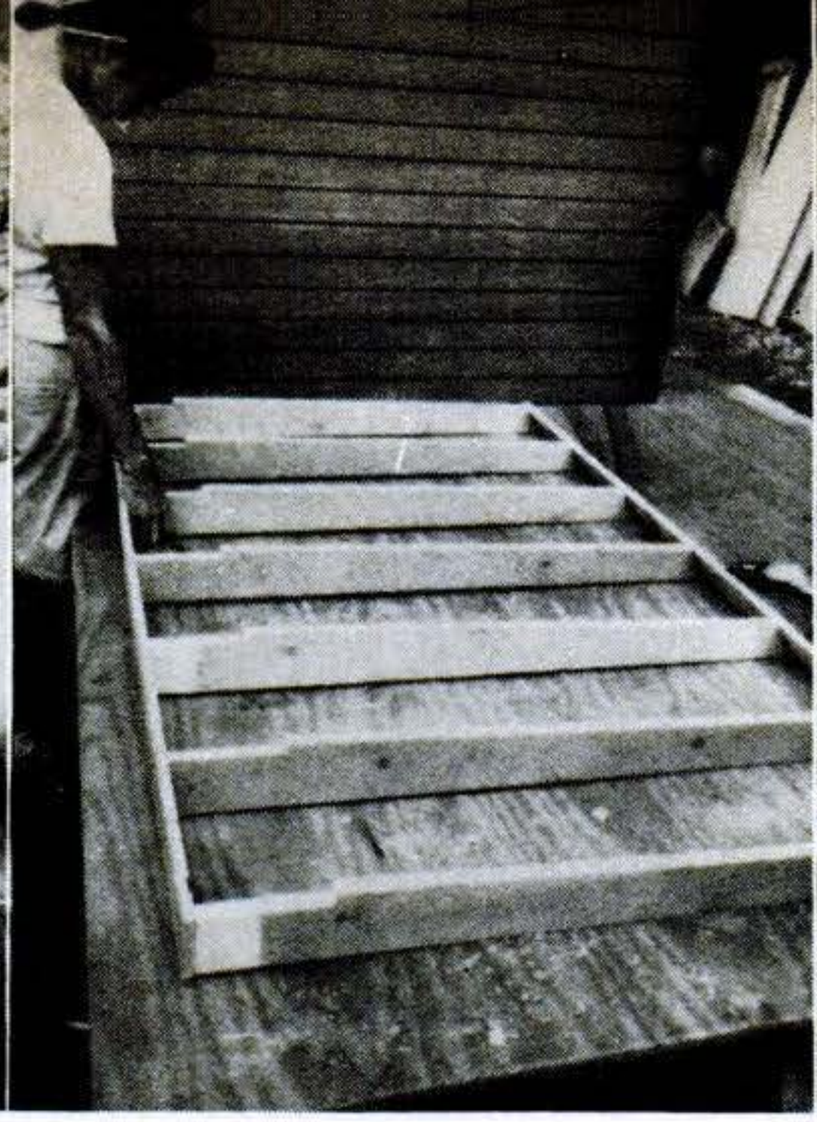
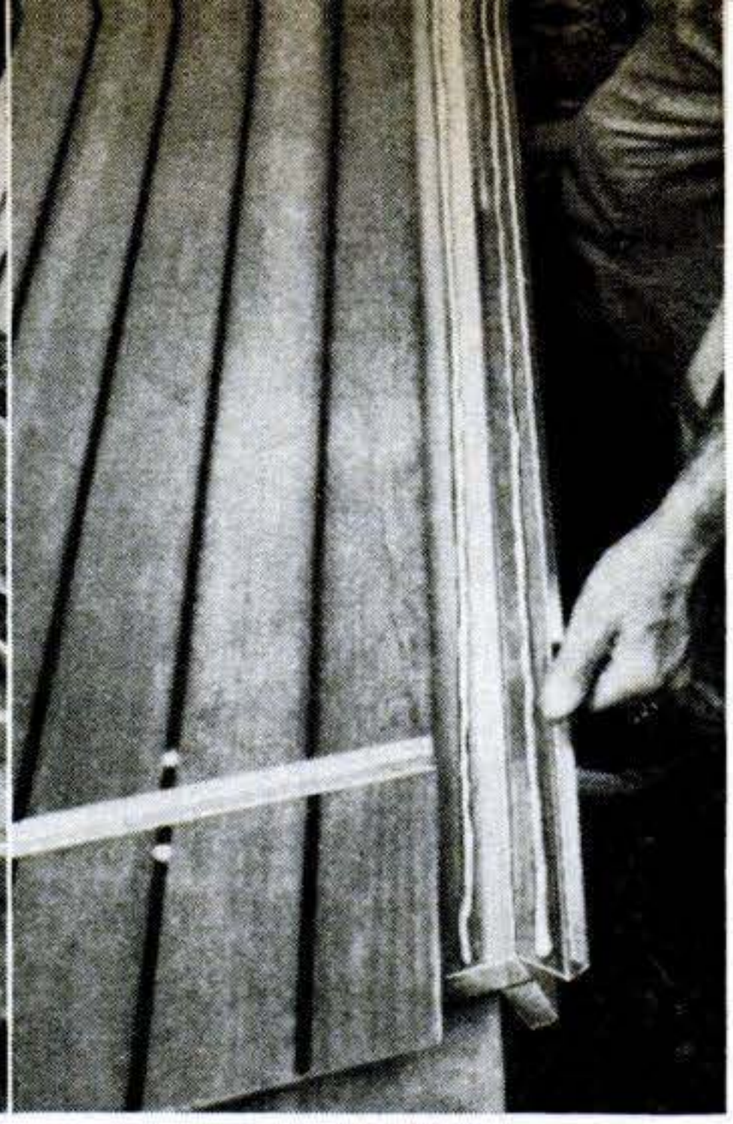


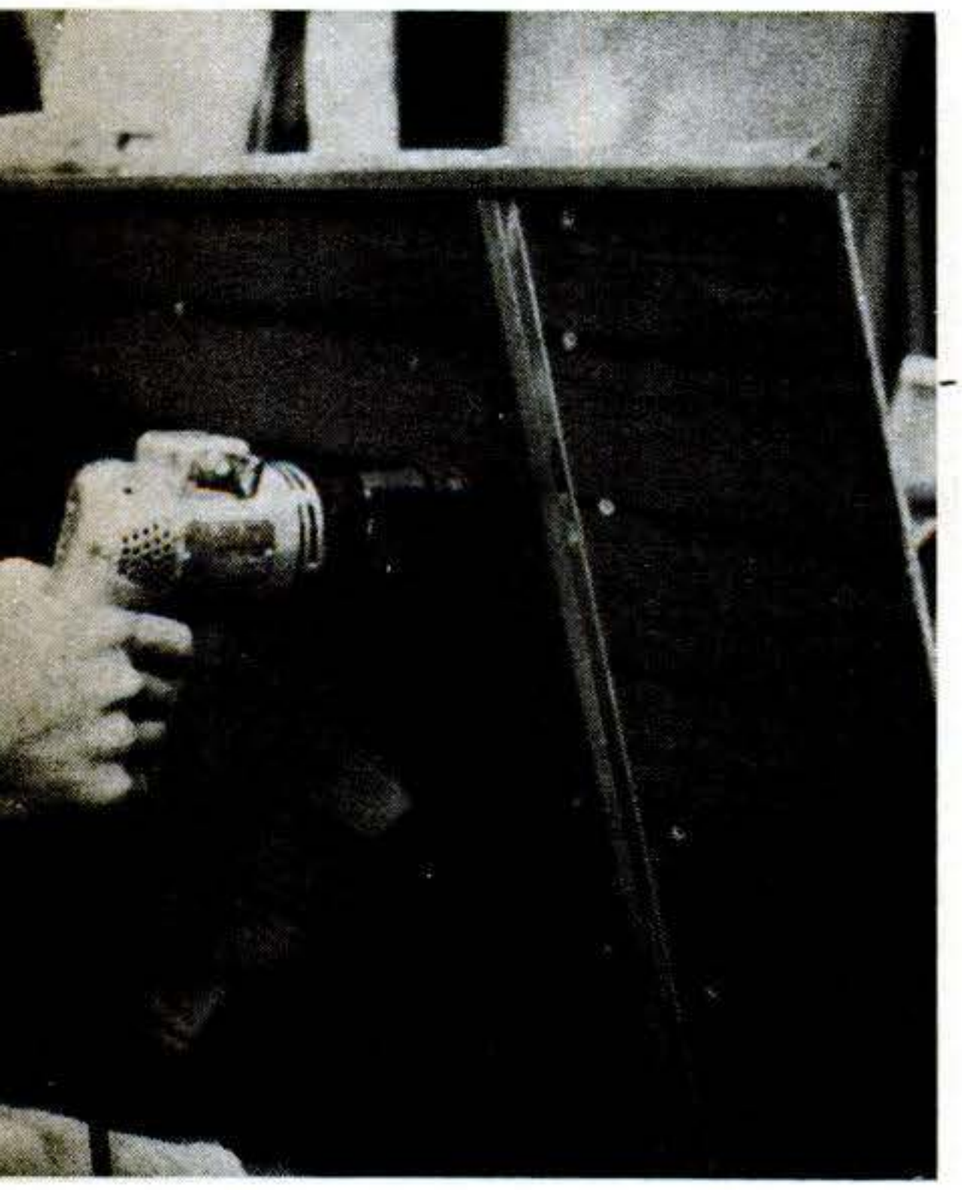
Framing angles are formed by beveling one edge of redwood one-by-sixes and assembling in pairs with screws to create camper profile.



Ribbed bed of over-cab compartment consists of one-by-sixes with the width tapered and one end cut at angle before joining to frame.



Trim channels of brake-formed stainless steel are attached along edge of framing angles to take plywood sides. Note sealant beads.



Power driver speeds setting of self-threading screws. Since heads show, space them in pleasing pattern (as along side-panel seam).

my teen-age sons) could build myself. This was a real challenge, since the last project I'd actually constructed had been a sandbox—some years back.

After past experiences with rented truck campers of various types, and discussions with fellow tourists, it became obvious that the great fallacy of the truck-camper trend is the second-car idea. Most people who buy a truck for use with a camper find they've acquired a second car that neither husband nor wife likes to drive daily—to work or to stores. Both are likely to prefer a standard or sports-model second car.

Choosing the vehicle. What we wanted was a compromise between truck power and passenger-car looks, ease-of-handling—and speed. The Ford Ranchero, with its large engine, power steering, power brakes, air conditioning, and load capacity, was a happy blend of workhorse and comfortable sedan, plus a racy touch of the sports car.

We were also convinced that many camper units for pickup trucks are too heavy and cumbersome for quick loading, or unloading to free the vehicle for other uses. Distinctly different needs separate long-distance touring from leisurely camping. The touring rig should be fast and lean, with only basic living essentials. Yet truck campers

Continued

Base box is ½" ply reinforced with one-by-two strips. Transfer pattern of truck's rear wheel housing onto work and cut for snug drop-in fit.

Add seat bases and platform frames to the base box; these will also support camper's side walls. Note elevated work platform (½"-by-4'-by-12' ply) to simulate height of truck bed. Resting on it is two-by-four grid that keeps box members square for fitting. Do final trimming after assembly.

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Johnson pioneered the concept of "quality in depth" boats with everything. So see for yourself (four models, 16′2″ to 19′1″) at your Johnson Boat dealer's, or write for free catalog to Johnson Motors, Waukegan, Ill. 60085, Dept. PS-B93. *Division Outboard Marine Corporation*

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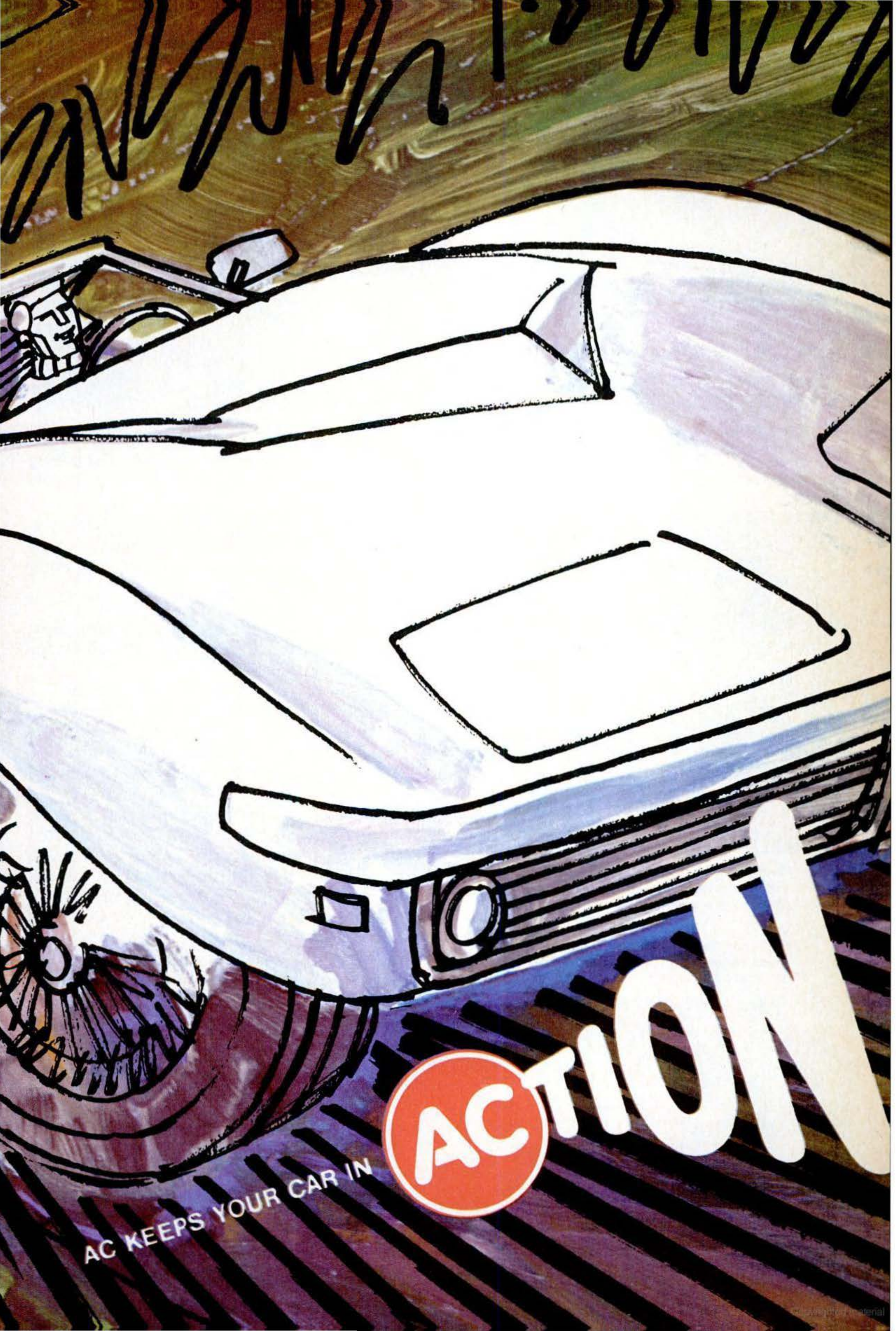
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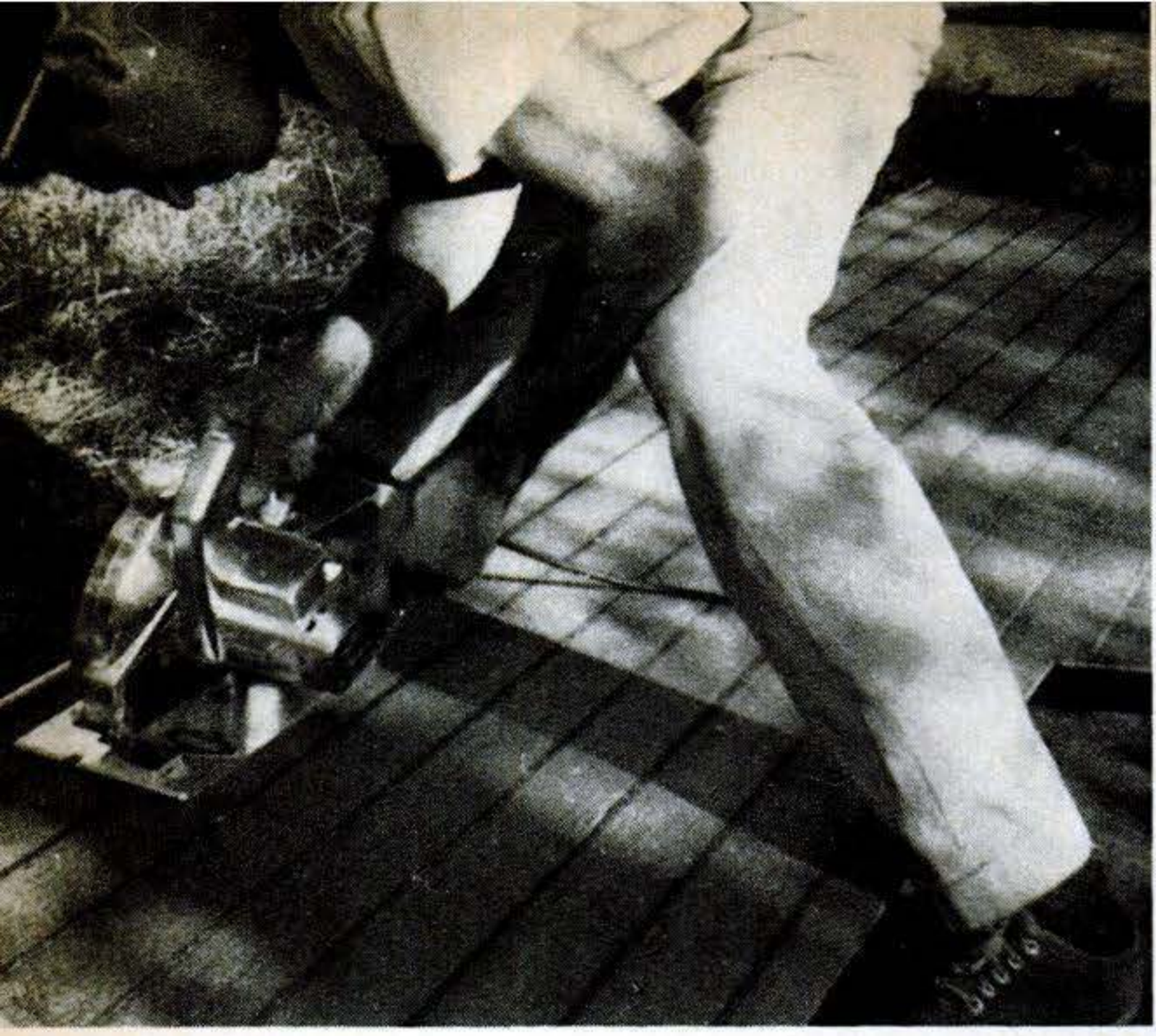
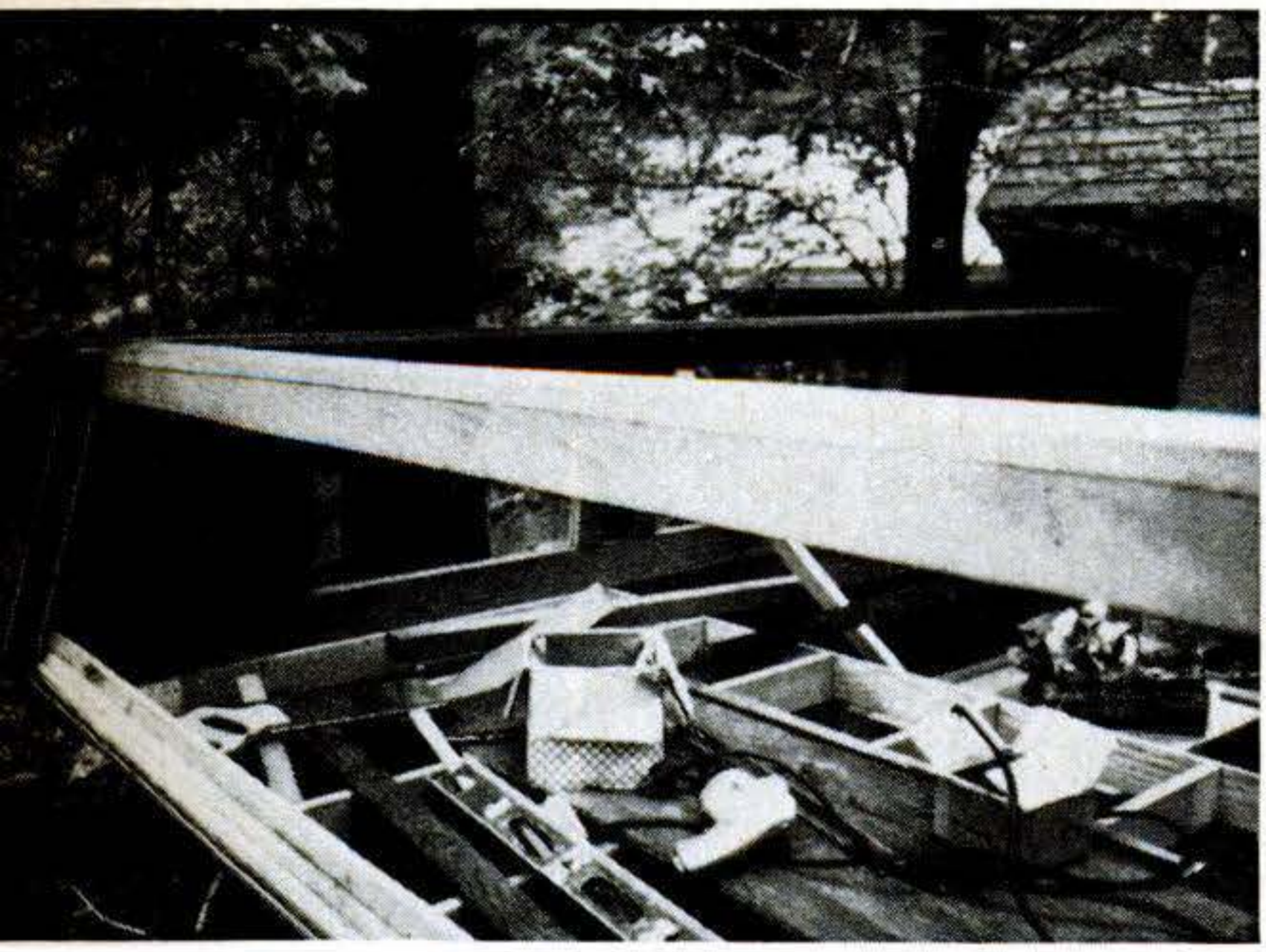


Window cutouts are made with circular saw before side walls are attached to base box. Saber saw will finish corners. Cutouts should be marked for cutting by tracing around frames of purchased sash units.

Channel trim closes all corner joints. Before applying, fill with silicone-rubber sealant. Flange of channel will be screwed to seat-level shelf cleat. Mating corner miters were cut with tin snips after trial fit.



Over-cab bed frame and front stretchers join and stabilize side panels in basic camper shape. Note: Stretchers are redwood angles like those on panels.

are becoming more and more unnecessarily luxurious. With a touring camper our aim, we determined that our completed rig must offer:

- Light weight.
- Sleeping and eating space for four.
- Above-average on-road visibility for camper passengers.
- Storage for clothing and supplies.
- Space for stove, sink, and cooler.

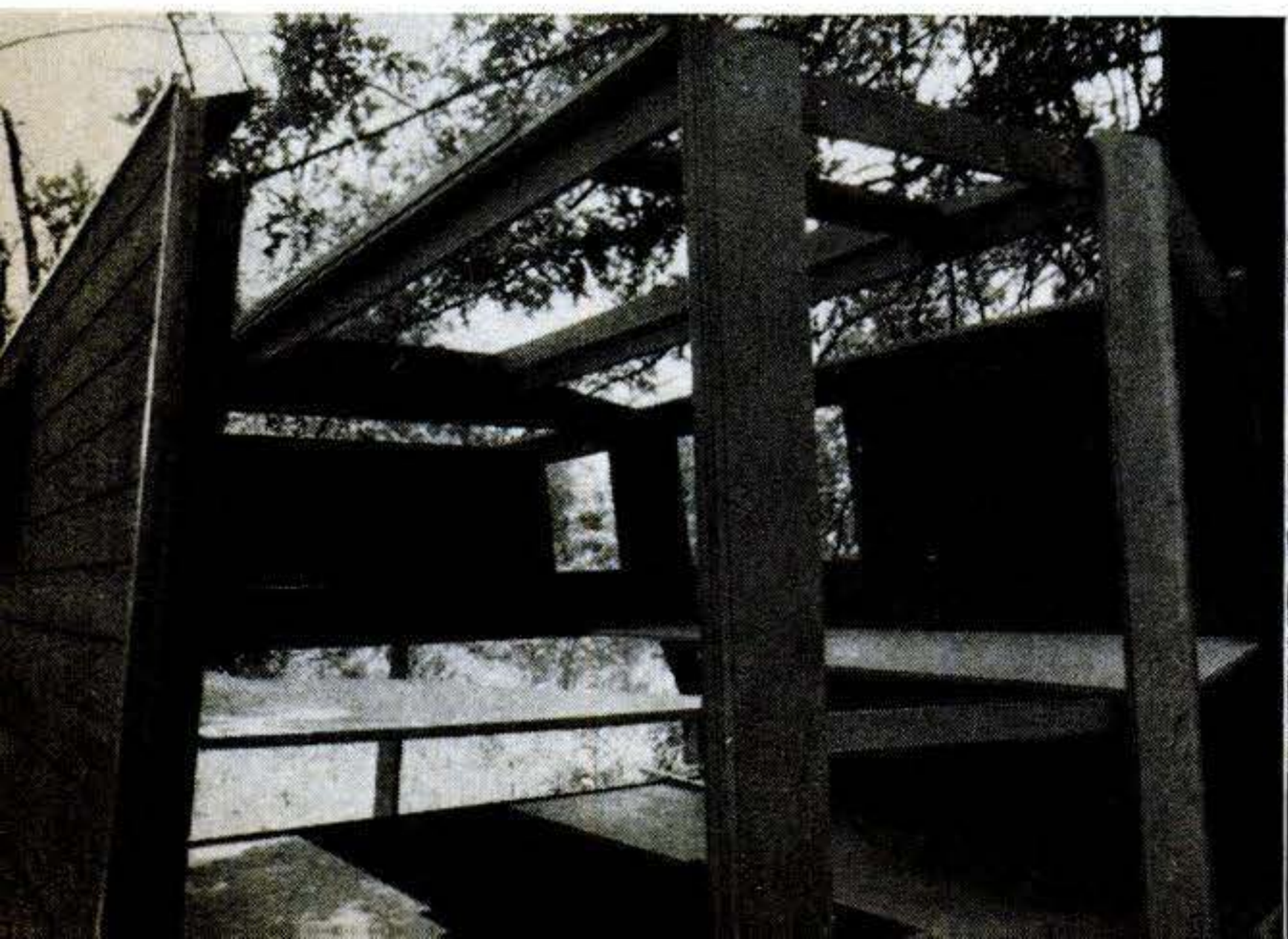
Our experiences with rented campers also taught us what we *didn't* want:

- Floor so high you need a step stool or ladder for entry.
- Roof so low you can't stand erect.
- Over-cab bunk so shallow you must squeeze in, usually bumping your head.

We decided that our touring camper didn't need a hot-water heater, shower, or

Continued

Add roof beams and frame the rear doorway. Plywood counter tops and seat/shelf panels also serve as structural braces. Cleats are temporary bracing.



Roof panels are sized to snap into perimeter stainless-steel trim, filled with sealant. Skylight curb is framed with redwood strips, screwed into angle.

You can judge a beer by its cover!

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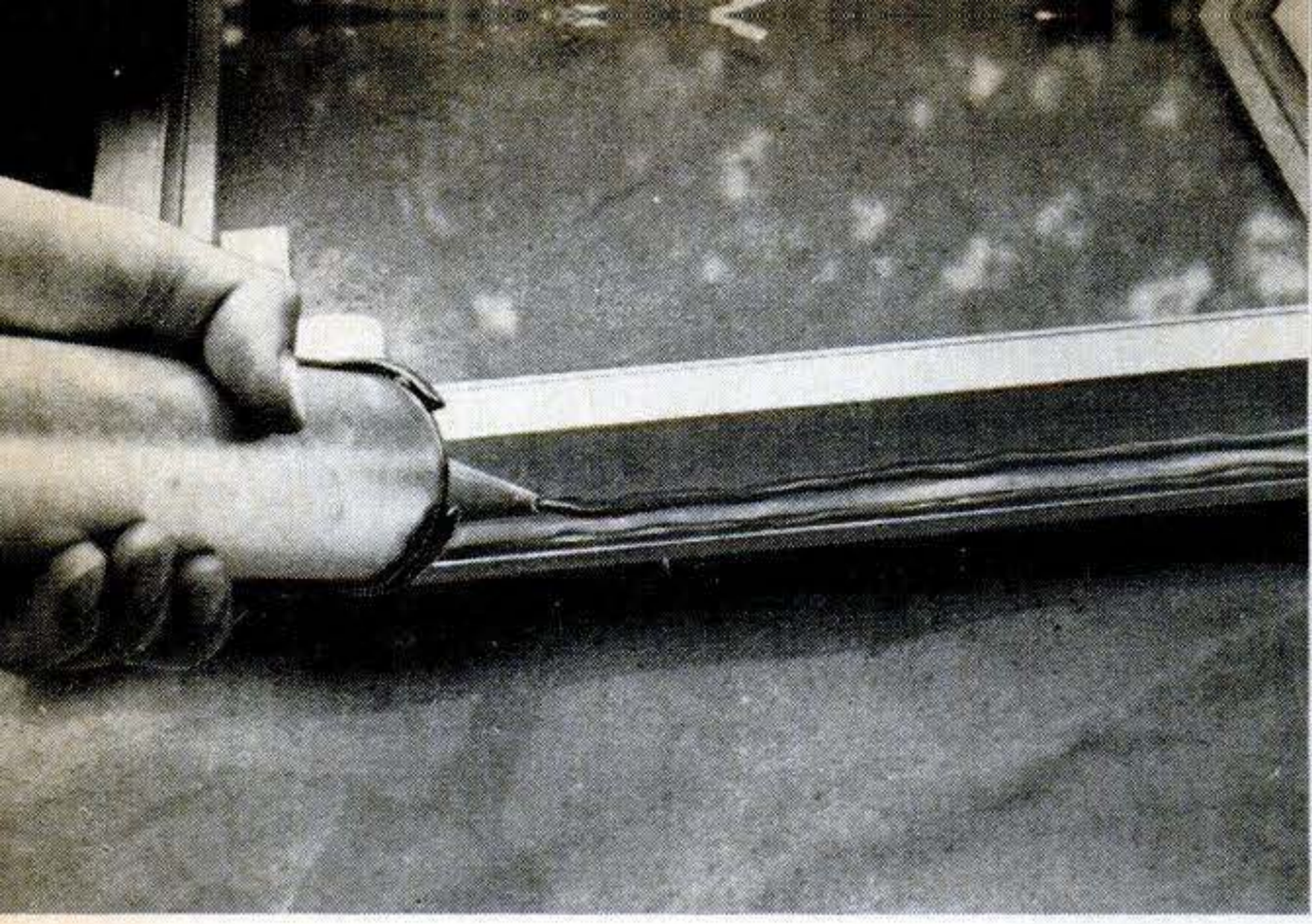
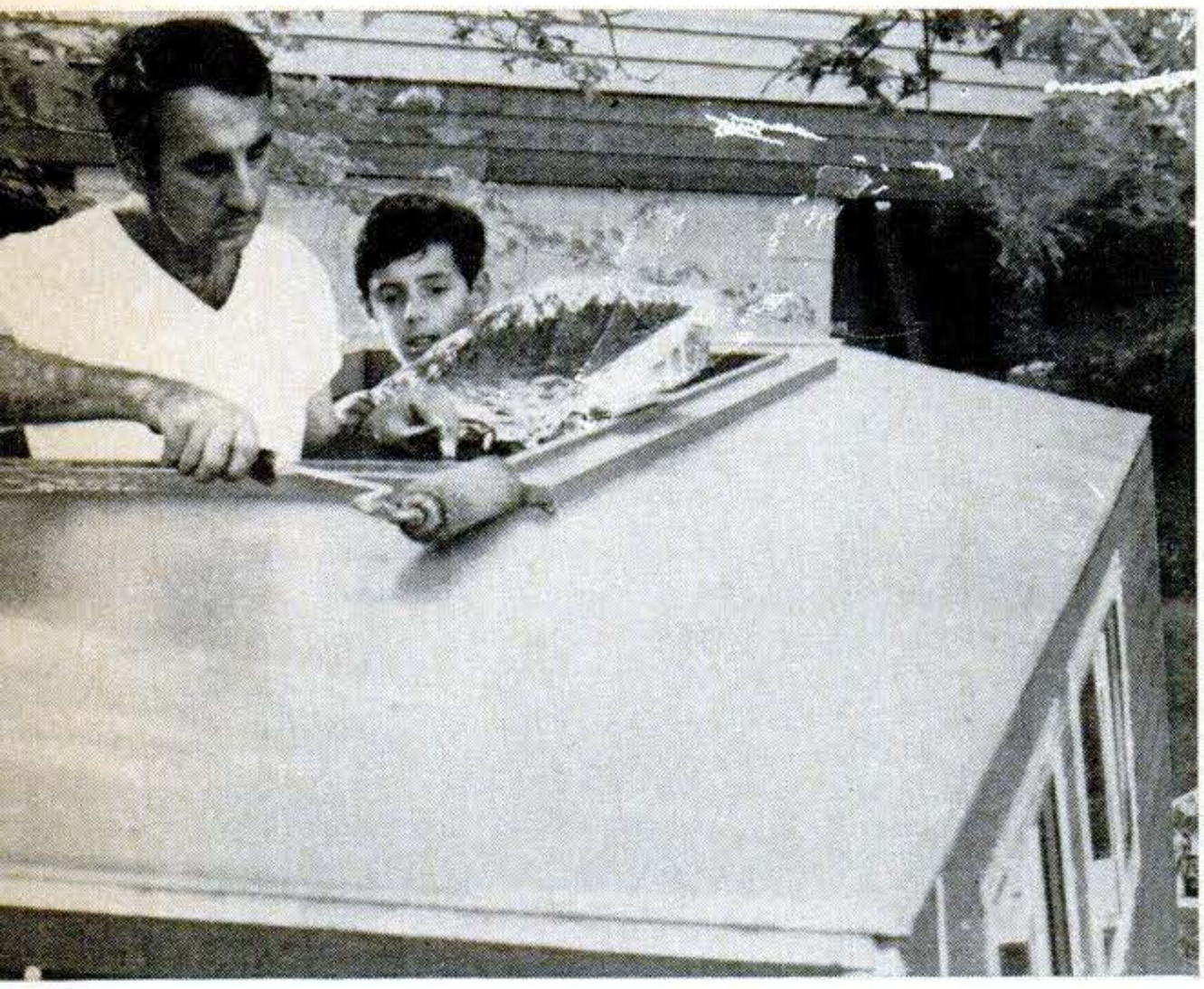


Window-frame molding is filled with silicone-rubber sealant before being set in place and secured with self-threading screws (right). Unlike these sash units in the side panels, the fixed front window over cab and lower sash that matches up with the cab's rear window have openings cut after assembly.



Waterproof coat—silicone-rubber roofing—is rolled on flat areas, brushed into corners. Base box and bottom of camper are also treated before mounting.

toilet. Almost every part of the country is blessed with campgrounds offering fine sanitary facilities. We also decided that (for our first trip, at least) our food service would be basically picnic style, with outdoor cooking morning and evening. The point of vacation travel is not, after all, to duplicate the home situation, but to bring fresh experiences.

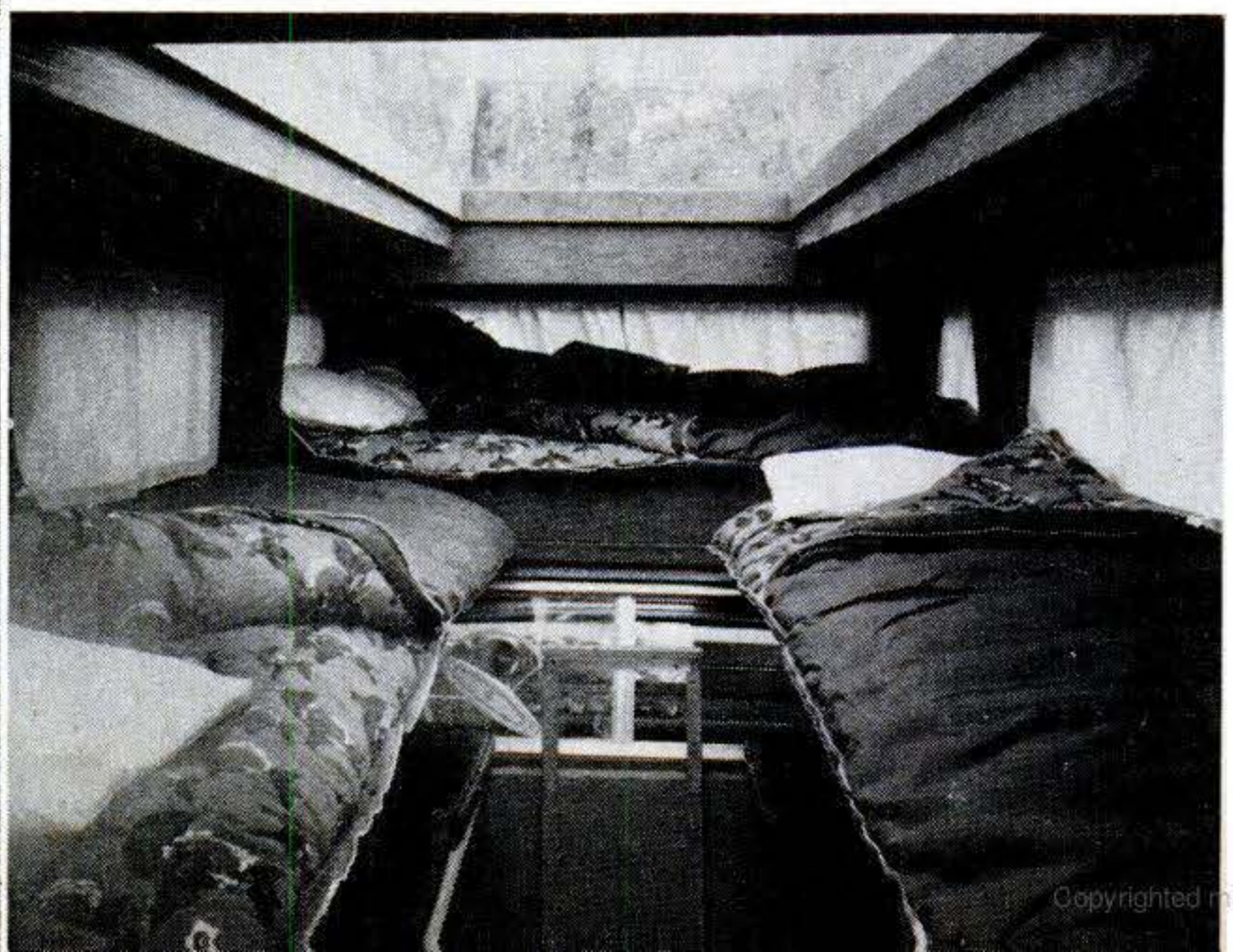
It's all redwood. For lightness, durability, and appearance, we chose to build of redwood—Simpson Shadow Groove prefinished redwood plywood, 3/8″ thick, over redwood framing. The plywood has a rough-sawn texture and burned-in grooves to simulate planks.

Assembly problems led to the development of a stainless-steel structural-trim system to hold the plywood, and protect and hide its raw edges. It contributes a

[Continued on page 195]

To load or unload camper, just winch up a jack device at each side until base box is above wheel housings, then move truck in or out. Unit will balance.

For campsite sleeping—literally under the stars—counters form beds along aisle. Two Coleman sleeping bags zip together for the double bunk at rear.



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A fast new way to blast carbon out of your car's engine.

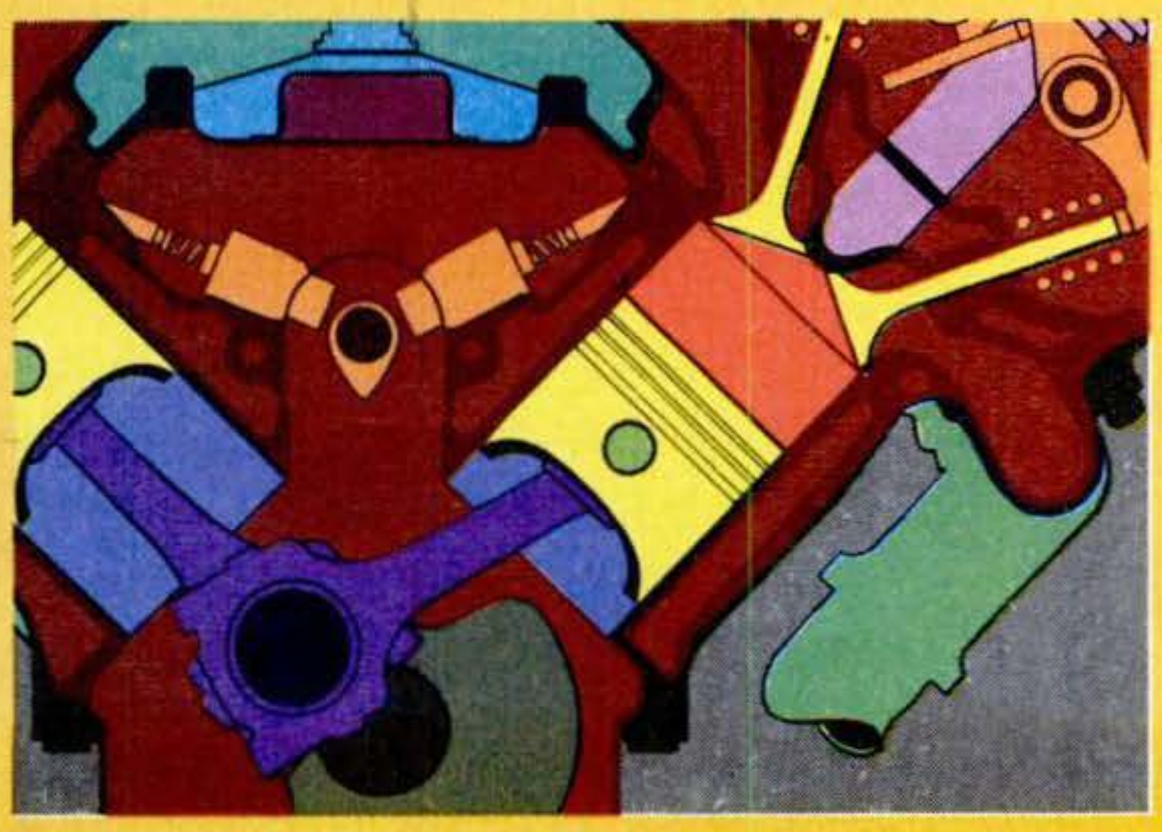
Sure, you know what happens when carbon deposits build up in an engine. You know how power drops. How pickup slackens off. How you start burning more gas and oil. How knocks and pings creep in.

You know all this. But sometimes it takes the jolting cost of an overhaul to make you really aware of the damage carbon deposits can do.

Carbon plus lead equals trouble. You get carbon deposits with everything you burn—logs in your fireplace or gasoline in your engine. But why can't the deposits in your engine be brushed away as easily as the soot that collects in a fireplace? Because gasoline contains lead compounds and other non-combustible elements. These additives, under enormous heat of combustion, combine with carbon particles to form tough, flinty deposits that build up, layer by layer, on pistons, valves and cylinder heads.

You sometimes see products that promise to dissolve the carbon in your engine. Don't be taken in. This kind of carbon is almost indestructible. Nothing on earth can dissolve it. You can't *dissolve* carbon deposits any more than you can dissolve diamonds.

But, with remarkable new Fuel Mix Tune-up Concentrate, you can rid your engine of carbon deposits, quickly and easily. As easily as pouring a can of it into your fuel tank. Fuel Mix doesn't do a thing to carbon. But it's murder on the lead compounds that "cement" the carbon particles together. It reacts chemically with these compounds, breaks them down so effectively that carbon deposits magically flake off—and are blasted out through your exhaust system.



In the combustion chamber, hard, crusty carbon deposits build up on pistons, cylinder heads and valves to cause knock, ping, fuel waste.

Good for engine break-in, too. Fuel Mix also protects your engine by lubricating the hot, oil-starved upper cylinder area to improve valve and ring action. Add a can to each tank of gas during the first 1,000 miles you drive a new car or rebuilt engine. It'll help prevent excess wear during those first critical miles of driving.

Use Fuel Mix regularly every 1,000 miles. You'll notice a big difference in engine performance almost immediately. Smoother, quieter running. Eager response. And power you forgot you had.

But please don't take our word for it. Look for Fuel Mix wherever fine automotive products are sold, and give it a try. Prove to yourself that it really works.

Before Fuel Mix is added to the fuel tank, cylinder heads are encrusted with layer upon layer of deposits of carbon and lead compounds.

After 4½ hours of driving, Fuel Mix has already removed most of the deposits, to improve engine performance and fuel economy.

GUMOUT Pennsylvania Refining Company
Cleveland, Ohio 44104

A fast new way to BLAST CARBON out of your car's engine. And it really works.

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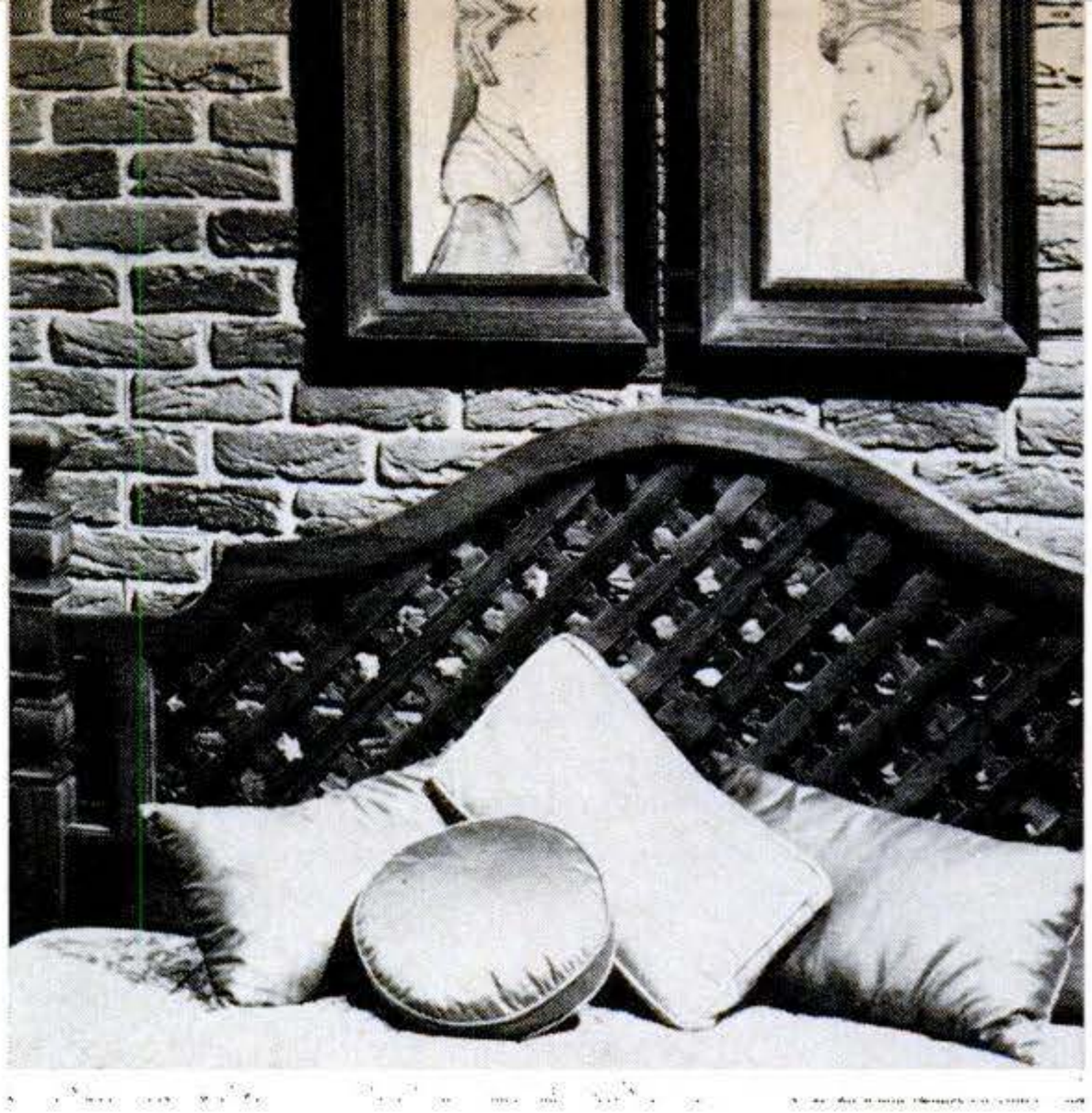
GUIDE TO HOME-IMPROVEMENT MATERIALS

Walls That Fool the Eye



Molded-plastic panels bring deep-textured wood or masonry effects to any room in your house—with wallpaper ease

By JACKSON HAND

It was a genuine brick-and-mortar mason who first recommended "three-dimensional-decorative wall treatments" to me—which is a little like having a diamond salesman turn you over to a friend in the rhinestone business. I was helping a neighbor in suburban Chicago do over his family room. One interior wall had to be brick, to round out the design he wanted. At his request, the mason came around, took one look at the situation, and said:

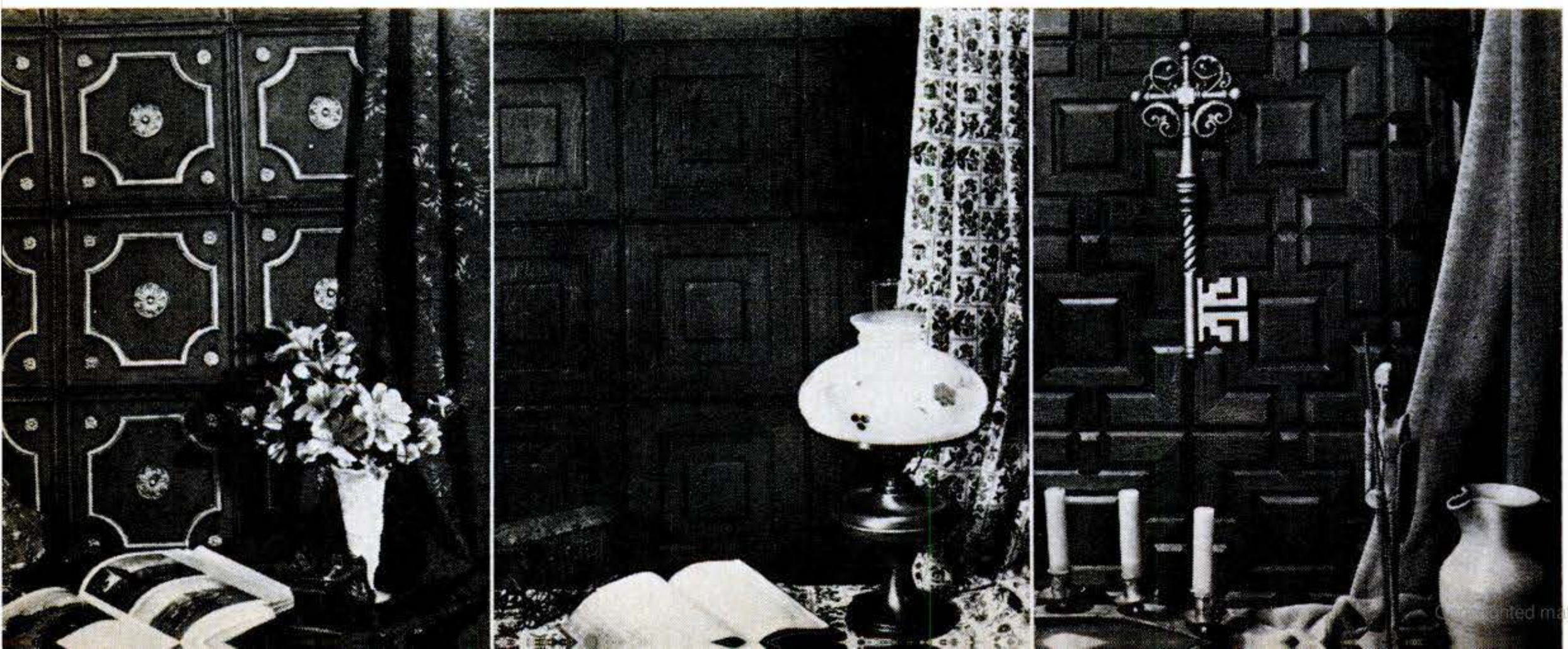
"What's going to hold up a brick wall? There's a basement under this room. Why don't you use that plastic brick?"

Much obliged, my neighbor stopped at a discount house for the brick-pattern panel material. At 30 cents a square foot he saved a lot of money—but more important, he solved a problem with rhinestones that diamonds couldn't handle, and the job looked great.

Although they call this stuff "panels," it doesn't fit in with the common idea of a panel—that is, a four-by-eight-foot sheet. Instead, molded-plastic wall coverings come in units about one by two feet. When the pattern is modular—such as brick or stone—the ends inter-fit, so seams barely show. Some patterns, such

Continued

Carved wood paneling effects that would be virtually impossible at today's prices for materials and labor are yours right out of a package. Choices include (from left) Provincial with gilded molding and rosette, bold and simple Colonial, ancient oak in a rugged design to set off Mediterranean furniture.



Your first thought is that Chevy is a good-looking pickup.

Here are some second thoughts:

Camper

Work truck

Second car

Hobby hauler

The point is: Chevy is one versatile vehicle. It's game for anything you are.

Whatever you do, you'll do it in style and comfort. Plush interior features thick foam seats. Sleek exterior offers a big 8½-ft. box on Longhorn models. Ideal for big cargoes or campers. And it all rides car-smooth on a deep-coil Independent Front Suspension.

Underneath it all, Chevy is tough. Double-tough in cab and body construction. Under the hood, there's power aplenty. Six or V8.

Want more? Like power steering or brakes? Your Chevrolet dealer can get it for you. . . . Chevrolet Division of General Motors, Detroit, Michigan.

CHEVROLET

Chevrolet is more truck
...day in, day out, day off!

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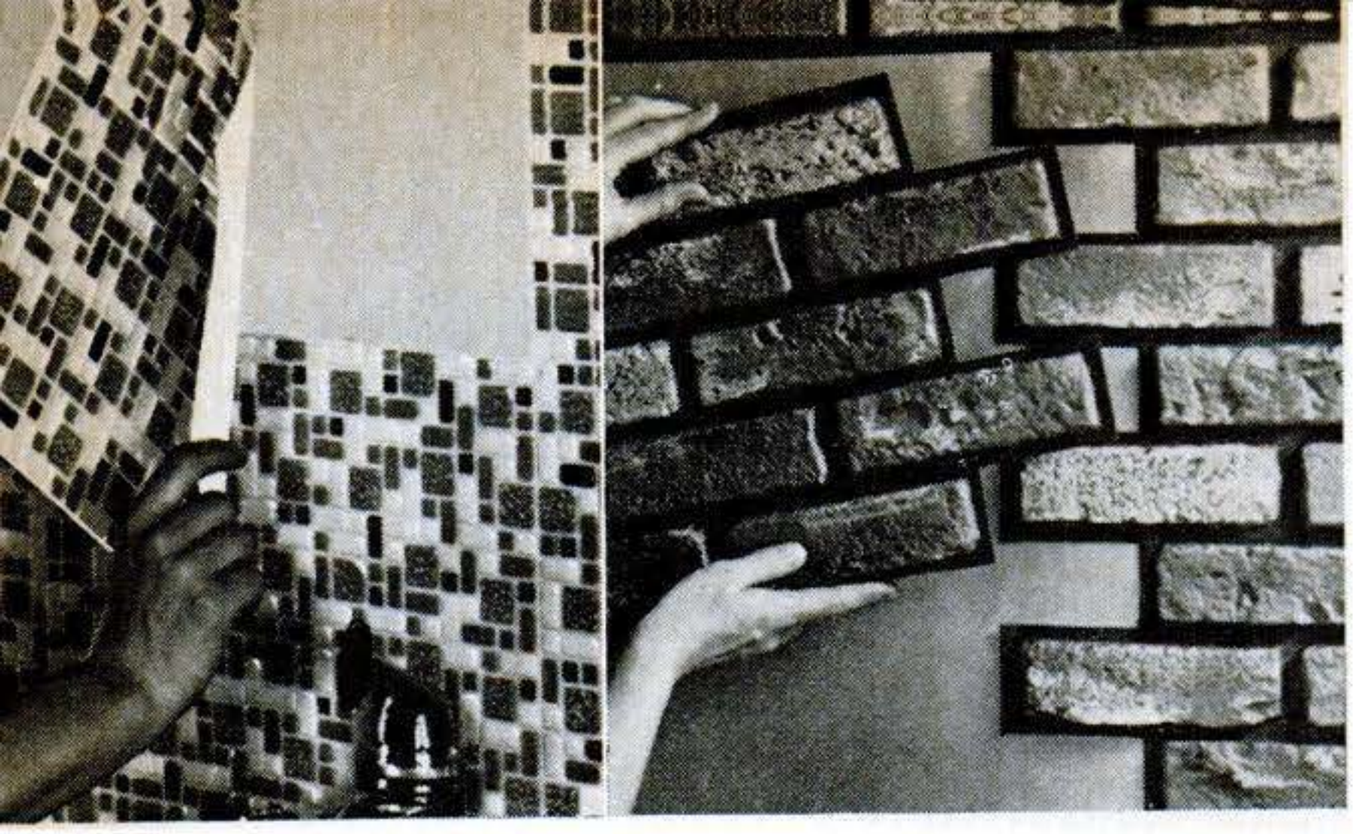
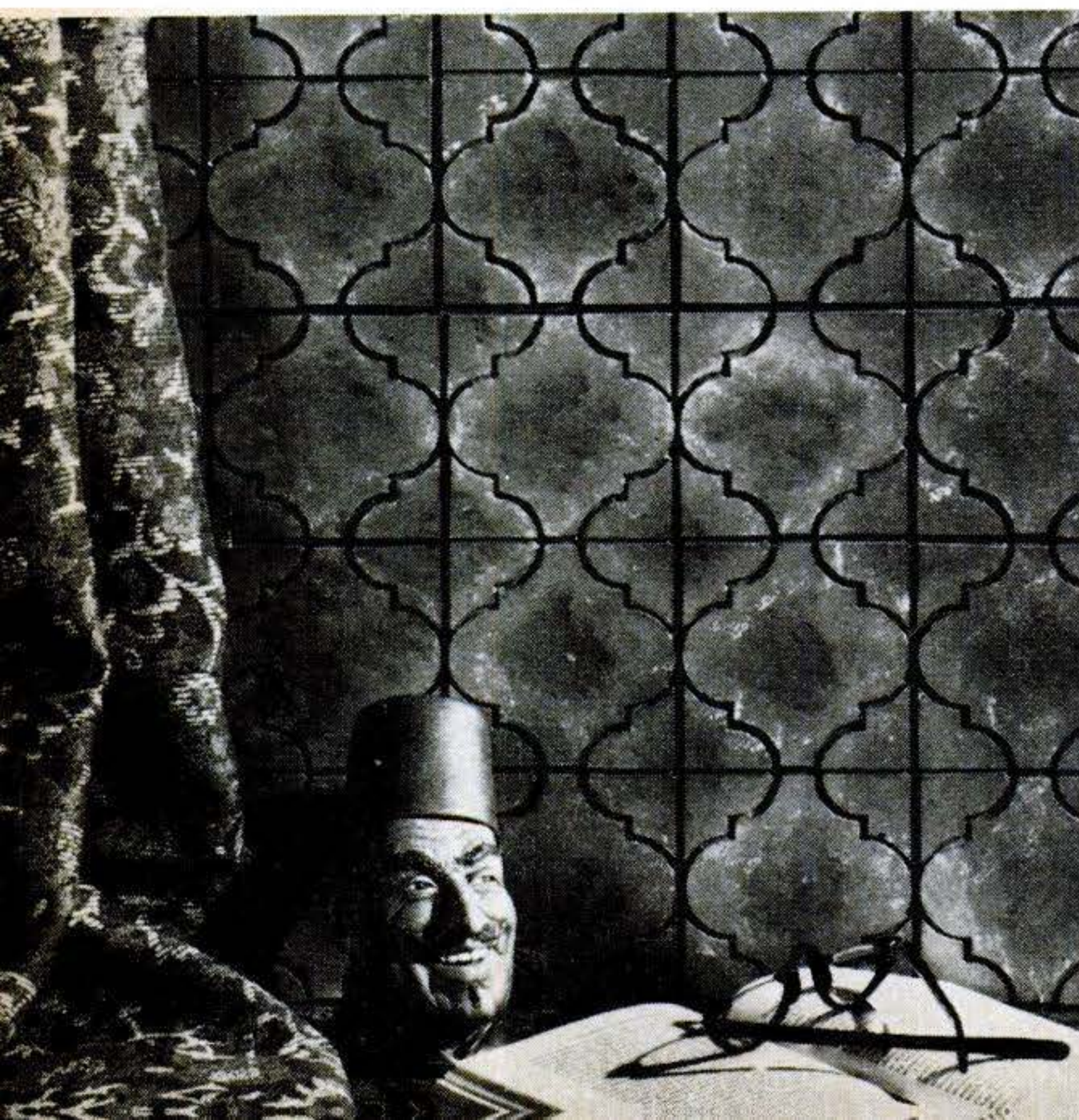


Patterns determine shape and size of panels. Above left, a mosaic tile pattern in one-foot squares—ideal for space between kitchen counter top and upper cabinets. Brick-pattern panels key into each other at mortar lines, which can be either dark or light. (All photos by Decro-wall, Elmsford, N. Y.)

Masonry designs also include ashlar patterns such as "limestone" above, available in several colors. Morocco tile, below, comes in warm terra-cotta hue; **it's Decro-wall's latest entry in their broad line.**



as wood carvings or one-by-one tiles, are square cut. In either form, there's a strip-off paper backing. When it's removed, the panels stick to just about any surface that's clean and dry. (Over bare plaster or unpainted wood, a prime coat of shellac insures better adhesion.)

Once up, the stuff forms a highly washable surface that very closely imitates a lot of different materials. The reproductions are flawless, since they are actual vacuum moldings in vinyl plastic, made in master molds taken from the real thing. Wood textures, the rough look of stone or brick, the polish of tile are all truthfully reproduced. It is only when you press on the high spots and find them hollow in back that you discover the thin film of the molding.

You can start to dream up your own applications for the molded-plastic wall paneling, if you consider some of its basic features:

- It weighs nothing. You can put it anywhere, without worrying about support. You can tote a whole wall of it upstairs under one arm—a big plus when remodeling an attic.
- You cut it with scissors. How about a stone wall in the stairway? Pretty simple and pretty good-looking.
- No-mess application. You don't mind putting it on a small area, because there is no tedious getting ready beforehand—and no cleaning up afterward.
- Within limits, the material bends. It will follow a wall that isn't quite true, without popping off. Also, you can follow curves, if they are not too severe. Patterns with small modules (one-by-one tiles, for instance) bend better than bigger patterns, such as brick or stone.

One interesting idea is the use of the material on nonwall situations, such as the front of a bar, on unpainted furniture (primed with a coat of shellac) to give it a distinctive and sometimes luxurious look, on the uprights of shelf units, on wooden planters, on folding screens.

Because of its waterproof nature, molded-plastic paneling is good in kitchens and baths, but the inevitable vulnerability of the adhesive system makes it unsuited for bathtub or shower areas. It's widely available from paint, hardware, and department stores, and from the major catalogue houses. PS

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step out

with a rotary mower from Allis-Chalmers

10 models: up to 22″ cutting width

The smoothest running, slickest handling rotary mowers that ever glided over a lawn. You'll find extra safety and performance features built into every Allis-Chalmers mower. Everything from a rear mounted engine that lets you nose under low hanging branches . . . to wind tunnel design that sets up grass for a clean cut . . . to smooth molded hand grips that feel as though they belong in your hands. There are ten fast-stepping Allis-Chalmers mowers to choose from: push-type or self-propelled. All powered by 4-cycle Briggs & Stratton engines: Easy-Spin Finger Tip Starting or instant Electric Starting. See them all at your Allis-Chalmers Outdoor Products Dealer . . . the man to see for lawn and garden tractors, riding and walk-behind power mowers, tillers and snow throwers.

ALLIS-CHALMERS

Outdoor Products 18-69

Box 128, Lexington, SC 29072

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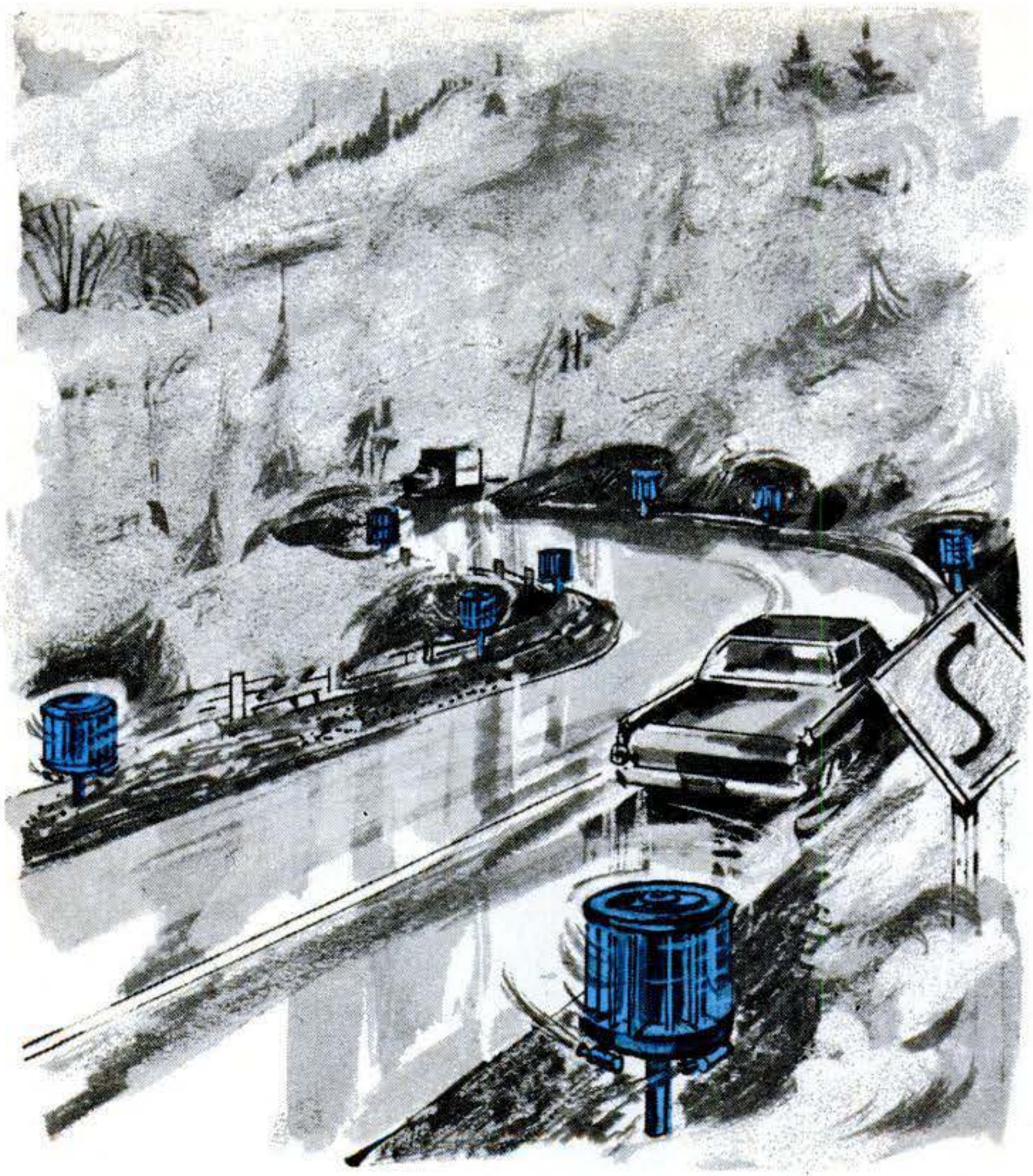
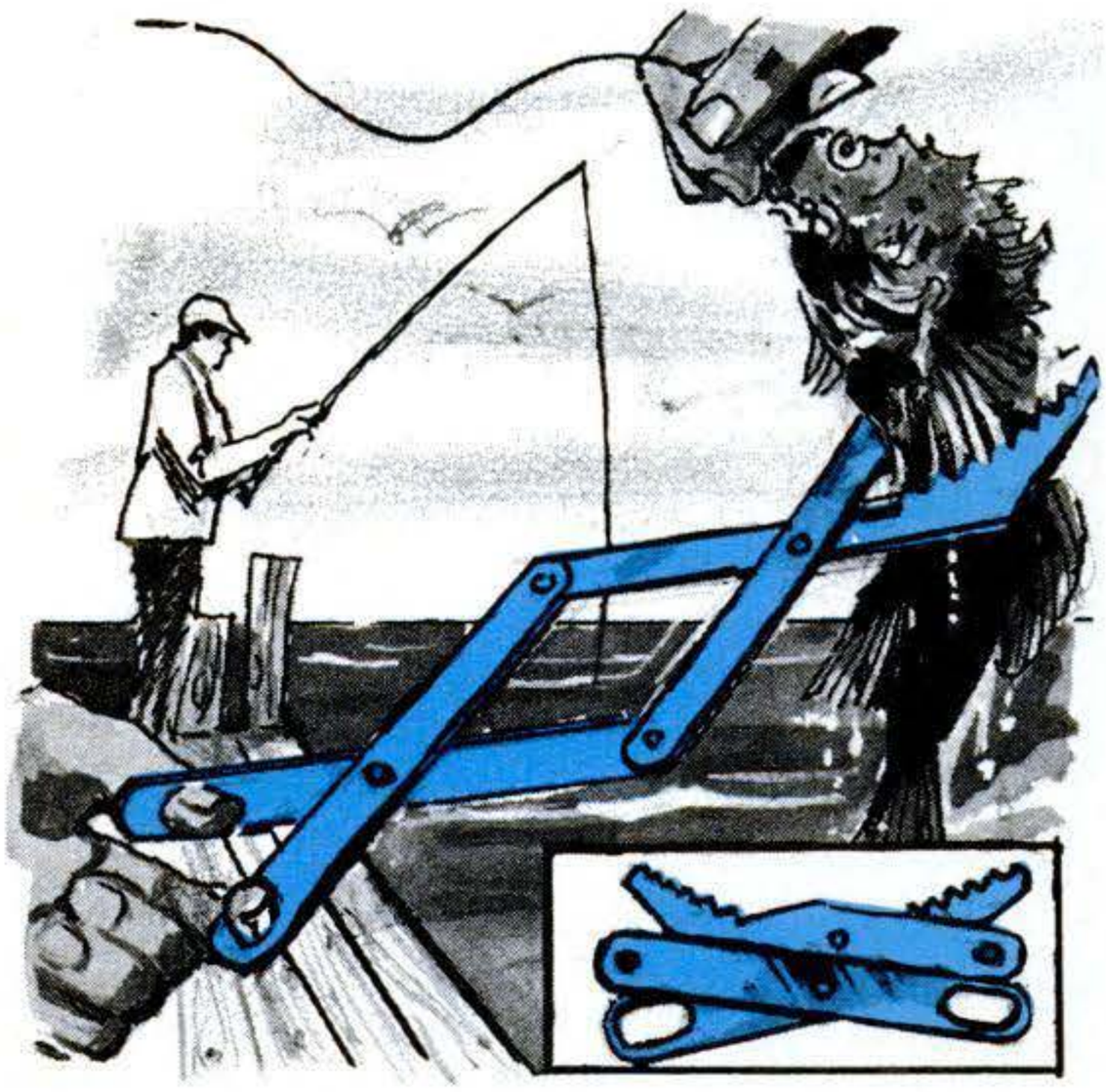
New Ideas from the Inventors

DRAWINGS BY WILLIAM CASTIMORE



Rocket fans dispel fog. Placed along highways subject to local fog conditions, high-speed fans shown in this recent patent might produce enough air movement to clear the mist. Fired by radio signal, rocket motors would whirl the cage-like structures to produce an air-freshening breeze. Electric or gasoline power might be used to sustain rotation. Fans could be fixed in areas of high fog probability, or truck-mounted for use where needed.



Extending tongs protect fisherman. Fold-out arms on these lazy-tong pliers would extend the toothed jaws to a safe distance from a fisherman's hand. They could be used, like regular fish pliers, to hold any catch, but are intended for eels, crabs, or long, spiny or sharp-toothed fish that could be dangerous if held too close. Tongs would fold up compactly to fit into a fisherman's tackle box.

Ladder bracket holds pail. You could set a paint bucket or other work-holding pail at exactly the right place if you had a ladder-gripping bracket like this. One wingnut adjustment would let you slide it up or down on the rail, another would move a support arm in or out. Hooks and slots on the arm would hold a bucket bail and form rests for a paintbrush, paint scraper, or other tools.

Continued

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Flying fisherman.

Wind up the prop on a 35-horse and roar off to wherever the fishing's wildest. You'll be piloting about two hundred pounds of zephyr-light marine aluminum shaped into a bullet bottomed hull. It'll get you through boiling rough water in a hurry.

Come fly a Seafarer and start something great on big lake water, rough rivers or offshore in salty seas.

Seafarer—14'2" and 16'2" models.

The **STARCRAFT**

Wide World of Recreation

BANGOR PUNTA'S WIDE WORLD OF BOATING
STARCRAFT / DUO / JENSEN / LUHRS / O'DAY / SEAGOING / ULRICHSEN

Write Starcraft Company, Dept. 9PS-3, Goshen, Indiana 46526 for a free catalog.

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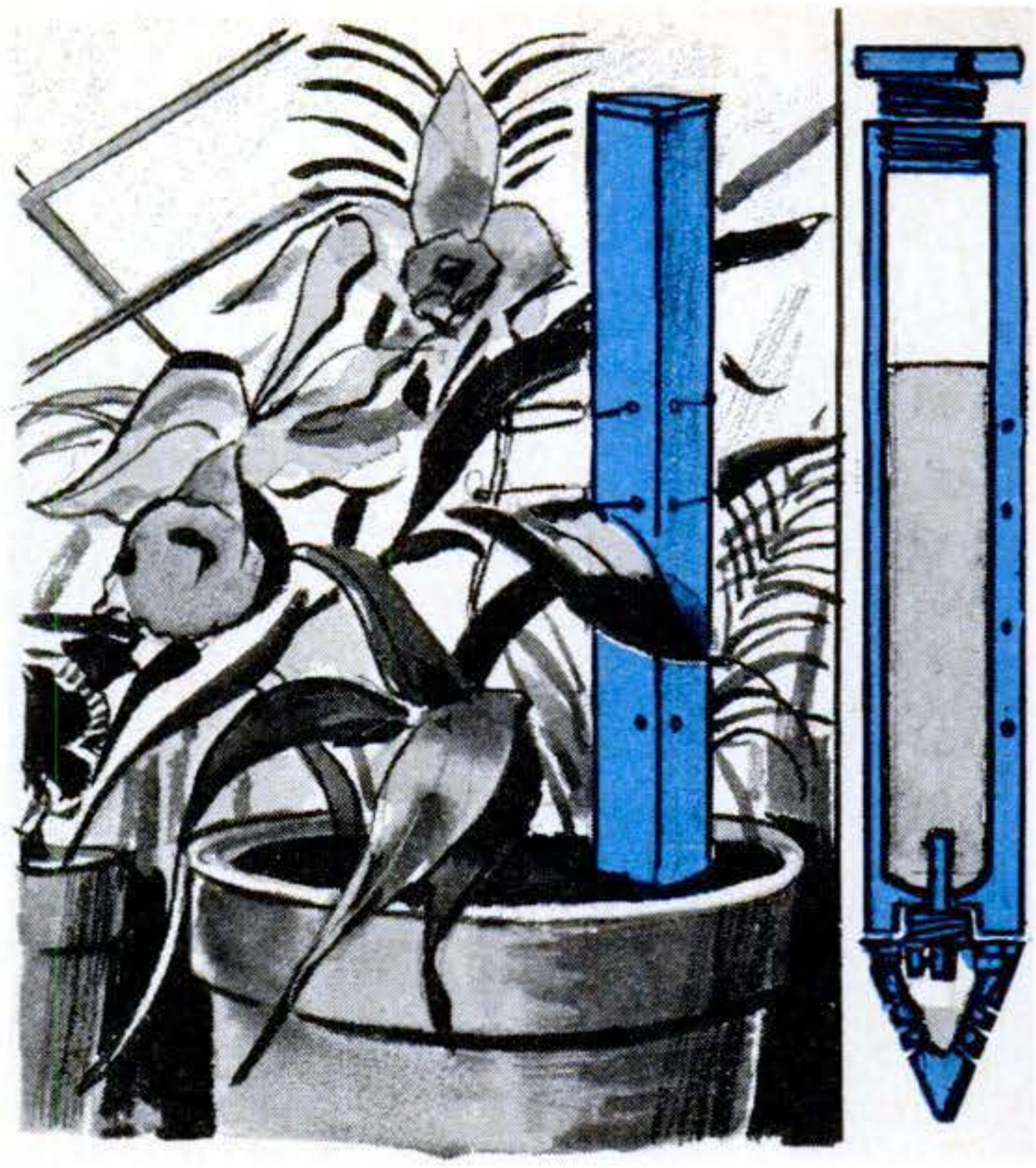
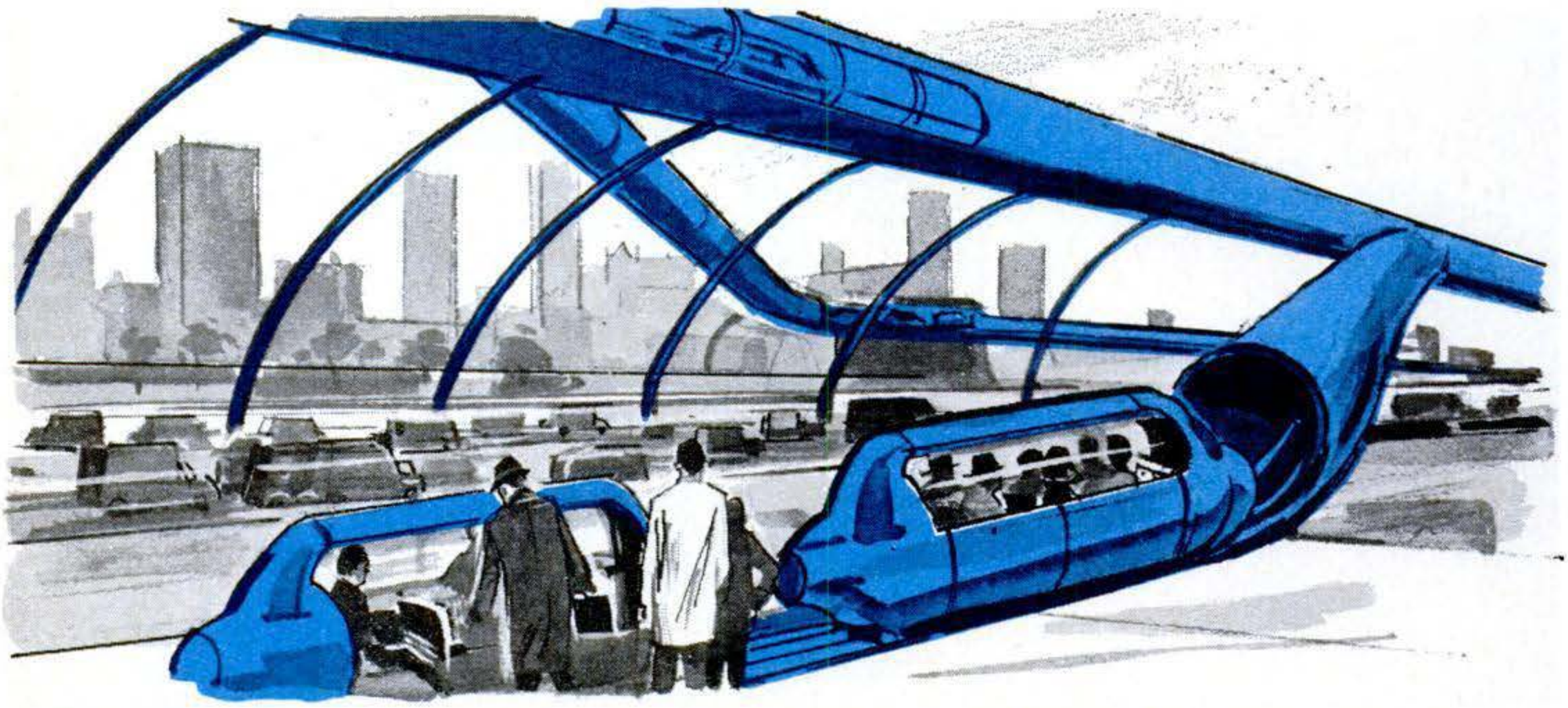
More New Ideas from the Inventors

Helmet light marks wearer. Emergency crewmen would be more visible with hard hats like these. Crowns formed of translucent, high-impact plastic would enclose blinker lights and rechargeable batteries. Coloring the light or plastic could distinguish functions such as utility or road repair.



Plant stake feeds roots. A screw adjustment at the base of this tube-centered stake would regulate the flow of water and soluble plant food through drain holes in the screw-on tip. By keeping the core filled you could insure that young or sensitive plants would be properly nourished and deeply watered.



Station loops speed train service. Routed by computers, small passenger cars in this transit system would speed directly to a button-selected destination, skipping stations in between. Air pressure could move cars through an elevated or underground tube; each station would be formed by a loop exiting from and reentering the main-line tube.

The following patents have been issued on these inventions: **Fog disperser**—*No. 3,407,733 to L. Copas, Port Arthur, Tex.;* **Fish tongs**—*No. 3,384,411 to C. Zlotnicki, Stamford, Conn.;* **Ladder bracket**—*No. 3,353,778 to G. Sylvain and G. Kean, Granby, Conn.;* **Helmet light**—*No. 3,358,137 to M. Sinclair and A. Fraser, St. Paul, Minn.;* **Plant stake**—*No. 3,345,774 to R. Delbuguet, Montreal, Que.;* **Transit loop**—*No. 3,403,634 to W. Crowder, Pontiac, Mich.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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[Continued from page 174]

finishing touch that—along with aluminum-framed window and door units—ties the camper visually to the chrome-trimmed vehicle. (The door and windows are Slide Vent units, made for the recreational-vehicle market by Philips Industries of Dayton, Ohio.)

The trim and window units, when secured to the plywood with silicone-rubber sealant and self-drilling screws, create a tight box. After 8,000 miles of fast and often rough driving, our unit developed no squeaks or rattles; and dirt infiltration, even on dusty roads, was virtually nil. Both the roof and the base box that fits into the truck bed were coated with liquid silicone rubber of the same family (from GE) as the sealant.

Building in performance. Studying the Ranchero spec sheets I'd got from Ford, I quickly saw that proper performance of any vehicle is directly related to the center of gravity of the load. The lighter the weight and the better it's distributed, the better the performance. I modified my camper design several times to balance the load side to side and to shift the center of the load forward of the rear axle.

Concern for reduced wind resistance led to another design feature. To lower the roof line, I'd have to raise the center section to permit standing. A plastic skylight from the Wascolite Division of American Cyanamid solved this with a dividend—a lookout spot.

It also caused some family arguments about who should do the driving. We must have been a startling sight on the road: three severed heads floating in a roof bubble, with one lone disgruntled driver in the cab below.

For cooking, food storage, and lighting in our Phase One camper, we chose Coleman camping equipment. Each sleeping area had a three-inch polyfoam mattress; bedding was eliminated by using sleeping bags. Rolled up, these doubled as dinette-seat bolsters.

Construction took our family a month of evenings and weekends. For loading the completed unit onto the truck (after stowing the removable tailgate in my garage), I chose a pair of Hi-Lo loaders made by the Camper Jack Division, Bock Industries, Elkhart, Ind. These units, of course, stay at home. There's no need to remove so light a camper on a trip.

With nothing but faith in our work—no testing, no dry runs—we packed up and ventured into the traffic of U.S. 1 and headed west. Yellowstone or bust!

Maneuverability and roadability. These were beyond my expectations. After two days of cautious low-speed driving, I tried the rig at speeds exceeding 55 m.p.h. Performance was superior to that of any pickup camper we had ever used. Our passing speeds were clocked as high as 85 m.p.h. In Denver, a hot rod challenged us to a "stop-light drag" and we left it eating our smoke.

As for appearance: We can't recall a daytime stop across America when we weren't questioned or complimented by service-station attendants, toll takers, or fellow tourists. In the parks, rangers often expressed gratitude to us for designing a unit compatible with the natural beauty of the wilderness.

The redwood finish got highest votes. And it stood up extremely well through weather and wind abrasion. Even a Kansas dust storm—severe enough to require headlights at noon—left no scars.

Tourists traveling in cars stopped us to ask about the unit and to voice surprise at seeing a camper mounted on a Ranchero. Many expressed interest in having such a vehicle as a second car, and confirmed our suspicions that they'd never consider a conventional pickup truck for this purpose.

Our one near mishap: We nearly ran down a woman who charged from the road shoulder like a startled doe, yelling: "You're beautiful! Stop, already! Where can I come by one of those?"

If she's a POPULAR SCIENCE reader, she now has her answer. The design has been copyrighted and patents are pending for my Tourineer Camper, Vista 360 Series; but detailed construction plans are available to PS readers for $10 (check or money order). Included are a Bill of Materials and a license to build one camper for personal use. The plans show how to adapt the four-adult model to sleep only two or three, to gain roomier accommodations.

You can win your own cross-country raves this summer. PS

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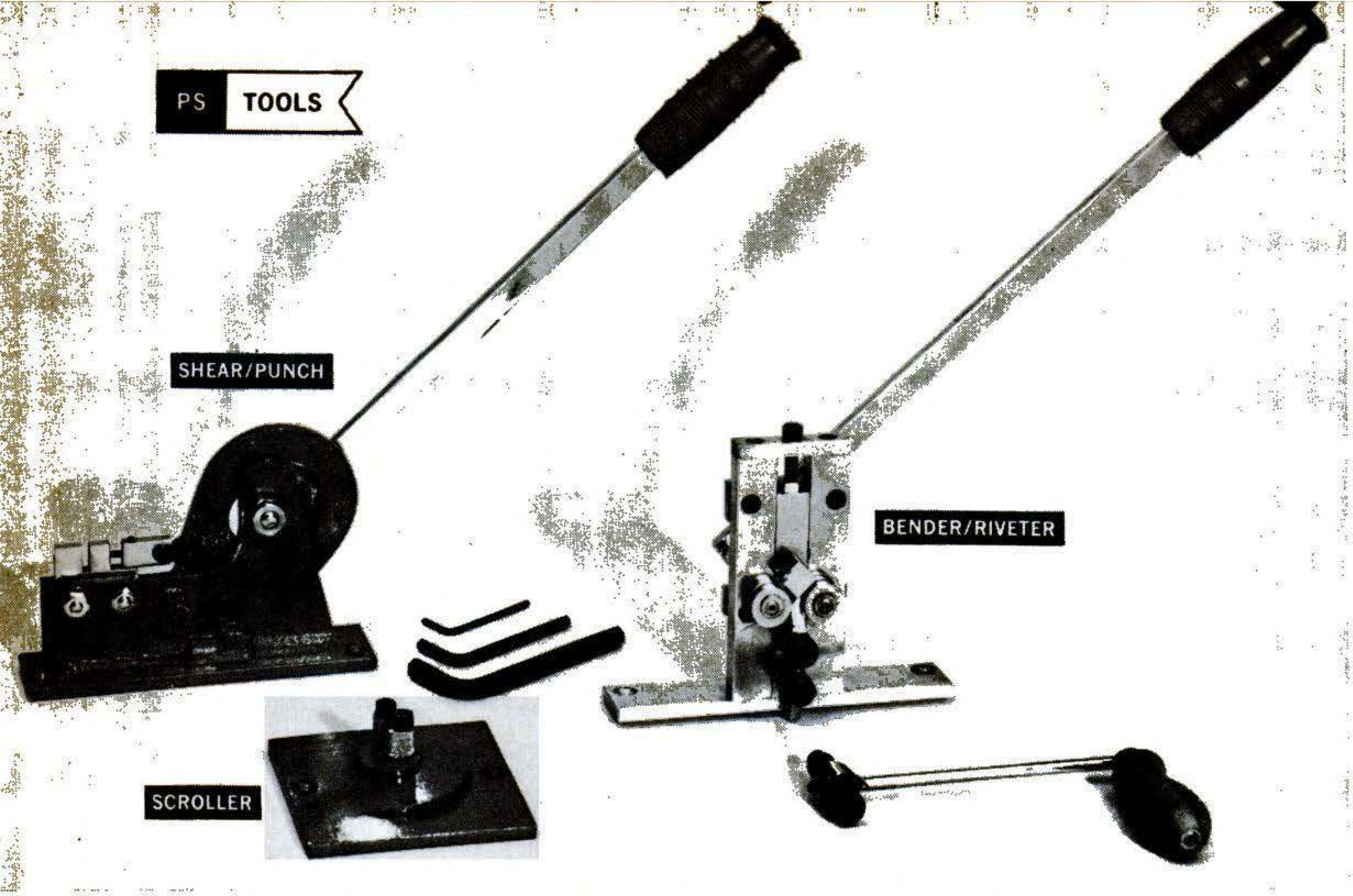
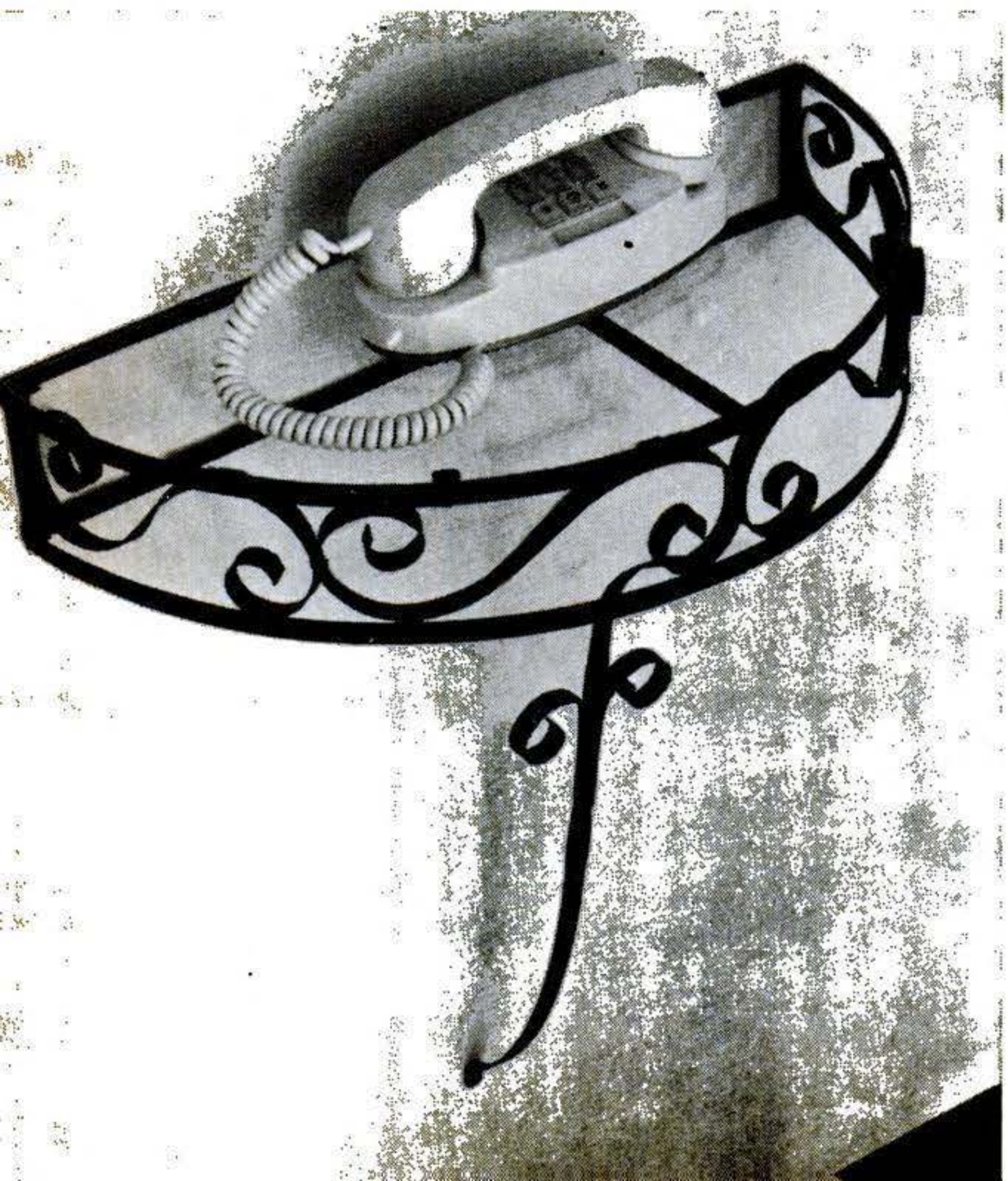


Metalcraft kit contains parts shown above. In right foreground is scroller handle.

It's Easy Now to Form Your Own Wrought Iron



By ROSARIO CAPOTOSTO

You can now become a master craftsman in ornamental ironwork. You can create many handsome "wrought-iron" objects that carry high price tags in the stores. You do it with a new set of easily used forming tools imported from England. They're shown above.

Your working material is 1/16" mild steel or aluminum alloy, 3/8" or 1/2" wide. These are generally available at hardware stores at around eight cents a foot. The tools shear, bend, punch, and rivet the metal. No welding is required.

Called Metalcraft, the kit consists of

Continued

Phone table cost author $1.60 for 20 feet of steel strip, another dollar for the 1/8"-thick clear-plastic top. Metal was sprayed with flat-black paint.

Copyrighted material

Only Cub Cadet has a big tractor transmission. Just one reason why it outlasts, outworks all the others.

Cub Cadet comes with a gear-drive transmission or a Hydrostatic transmission. The gear-drive transmission is exactly the same as that used in our bigger Cub tractors. The Hydrostatic Drive is a scaled-down version of the exclusive transmission used in our farm and industrial tractors. Both are direct drive from engine to axle. There are no belts to slip or snap.

Here are some other reasons Cub Cadet outworks and outlasts the rest. Full-length, heavy channel steel frame. Big, husky axles. Auto-type enclosed steering. And a lot more.

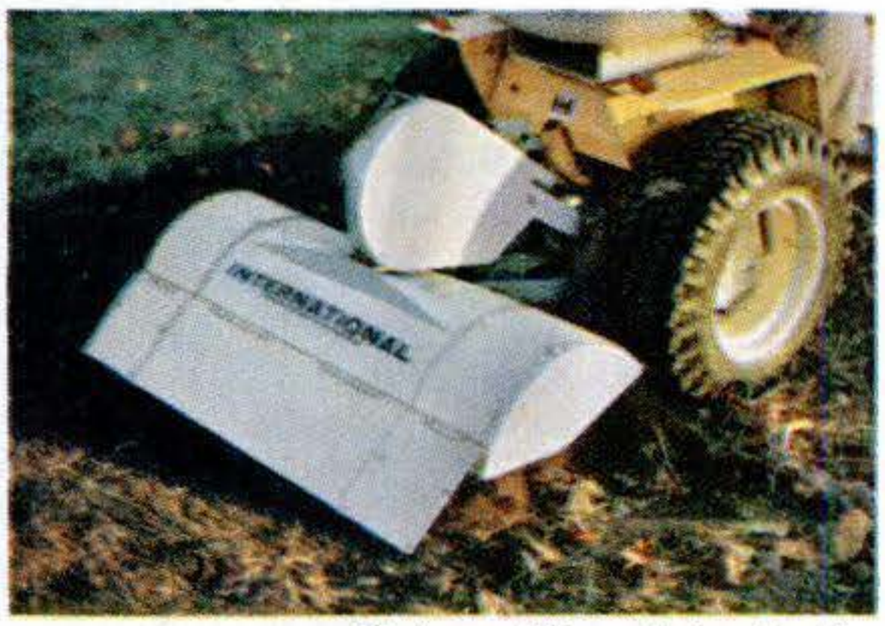
We build Cadets that way—because that's the way we've built almost 5 million bigger tractors for people who earn their living with them.

No wonder Cadet is the only lawn and garden tractor that works so hard, on so many jobs, for so many years. No wonder more people buy Cub Cadet than any other lawn and garden tractor.

The gear-drive Cub Cadet comes in 7, 10 or 12 hp. And Hydrostatic drive in 10 or 12 hp. Over 50 attachments to choose from. Your International dealer is in the Yellow Pages under "Lawn Mowers" or "Tractors." See him for a demonstration.

Quick-attach rotary mowers—38, 42 or 48 inches wide.

All-steel dump-type box trailer—800-lb. capacity.



Rotary tiller—7-in. depth, 32 to 38 in. wide.

Heavy-duty snow throwers—36 or 42 inches wide.

Want more power? See the new International Cub 154 Lo-Boy—with a 15 hp water-cooled engine and 60-inch mower.

Cadet is for keeps

International, Cub, Cub Cadet and Lo-Boy are trademarks registered by International Harvester Company, Chicago 60611.

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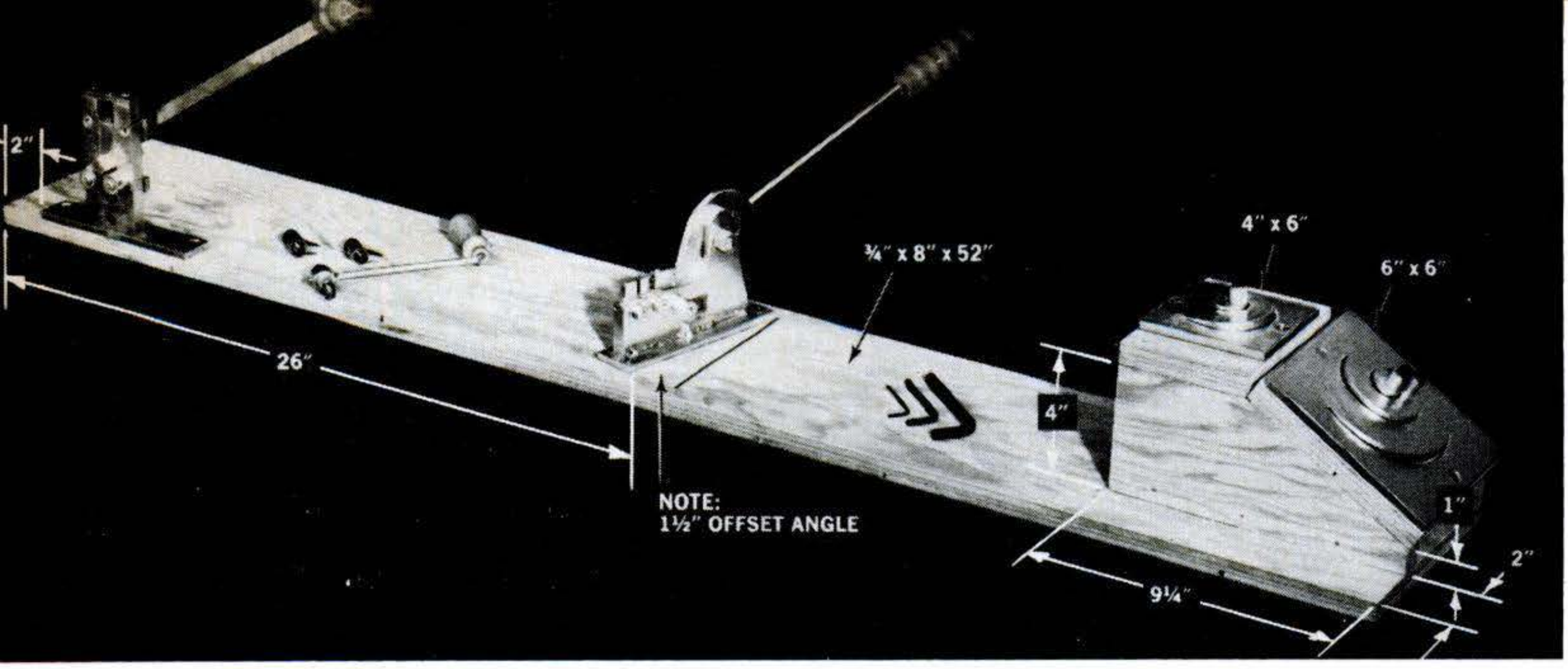

Mounted on a ¾"-plywood workboard like this, the tools won't interfere with each other. Note how large accessory scroller is mounted at an angle. Place bender so its front edge overhangs edge ⅛".

three basic tools: a scroller; a punch and shear; and a combination bending, rolling, and riveting tool. The U. S. distributor is Creative Educational Services, Inc., 1280 Route 46, Parsippany, N. J. 07054. You can order the three tools and a selection of metal strips for $59.50. Later this year the same kit will sell in retail outlets for about $20 more. Before you order you can send for free information. Or enclose 75 cents for a design booklet and a sample strip of metal.

Accessories available include a larger scroll former and various items such as leaves, rosettes, candlestick pans, and lantern housings. The accessories are described and priced in a how-to booklet that comes with the kit of tools.

Setting up. You can use the tools on the kitchen table or your workbench by clamping them in place. However, it's better to screw them down. I quickly found that it is best to keep them far enough apart so the work has clearance.

I developed a special workboard to keep the tools permanently set up in the smallest possible area. The shear, at the center, is set at an angle. This permits handling a standard 6′ steel strip

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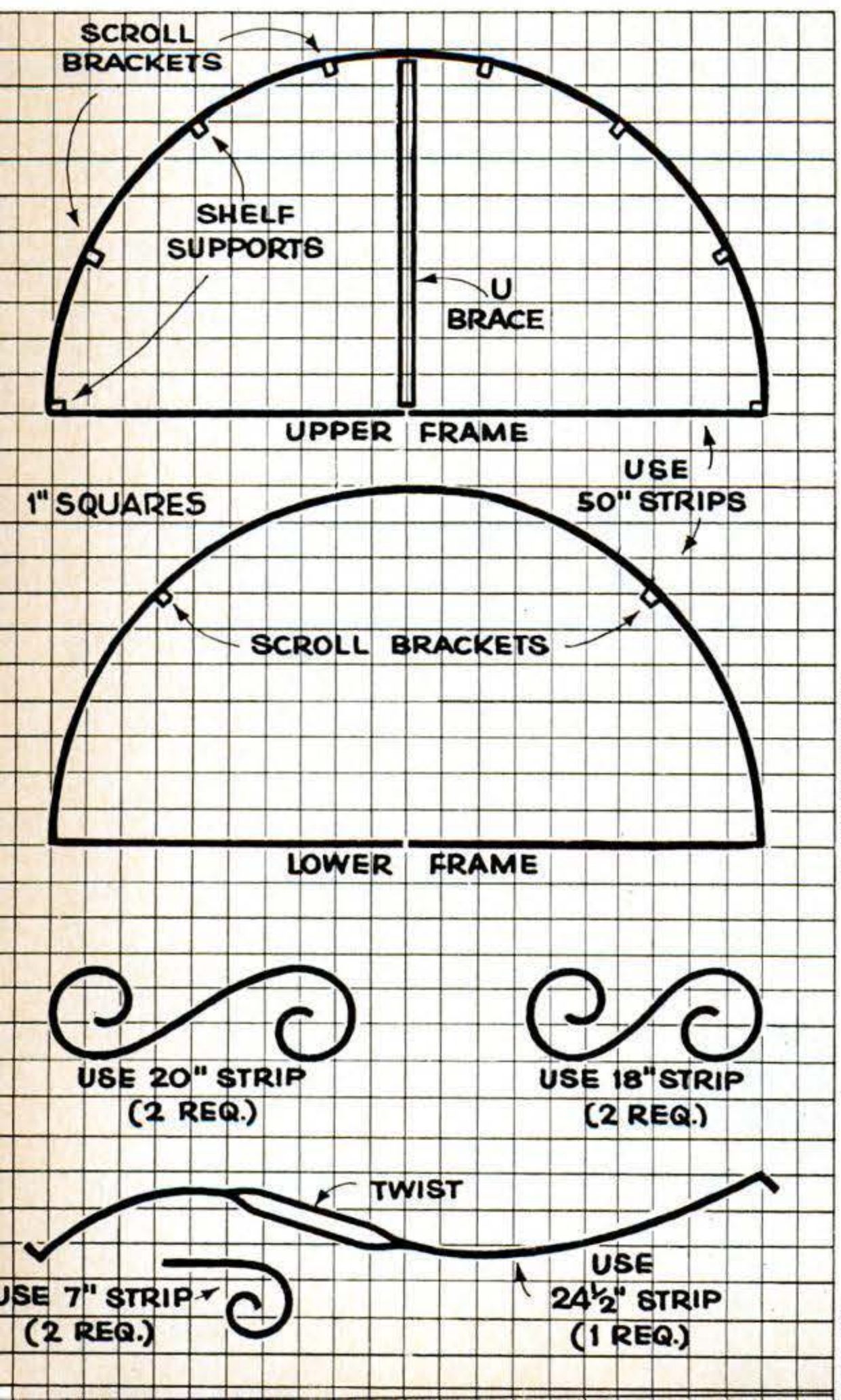
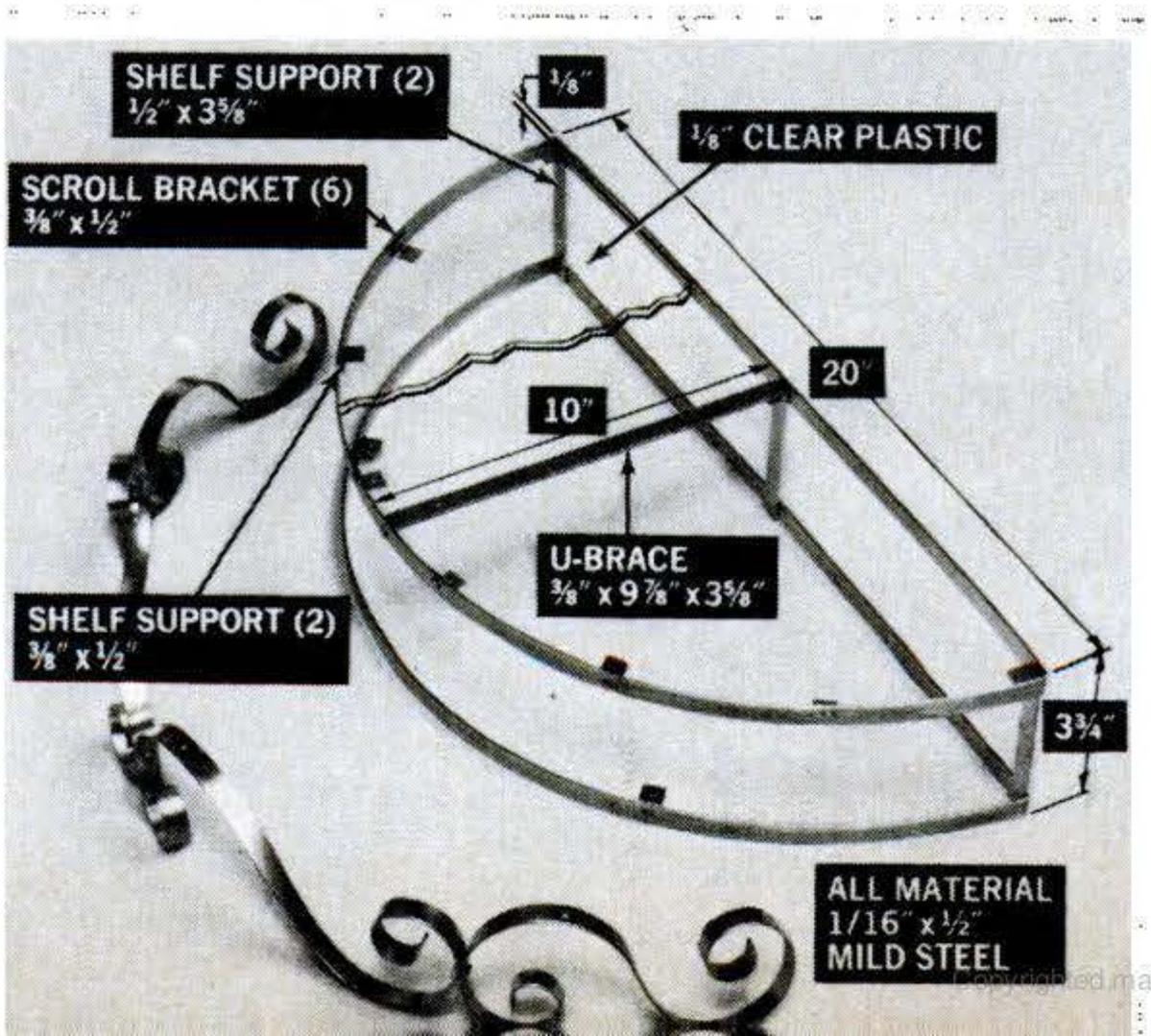


As demonstration project in how to use the new tools the author made a wall-mounted phone shelf. Photos on following pages show how he did it.



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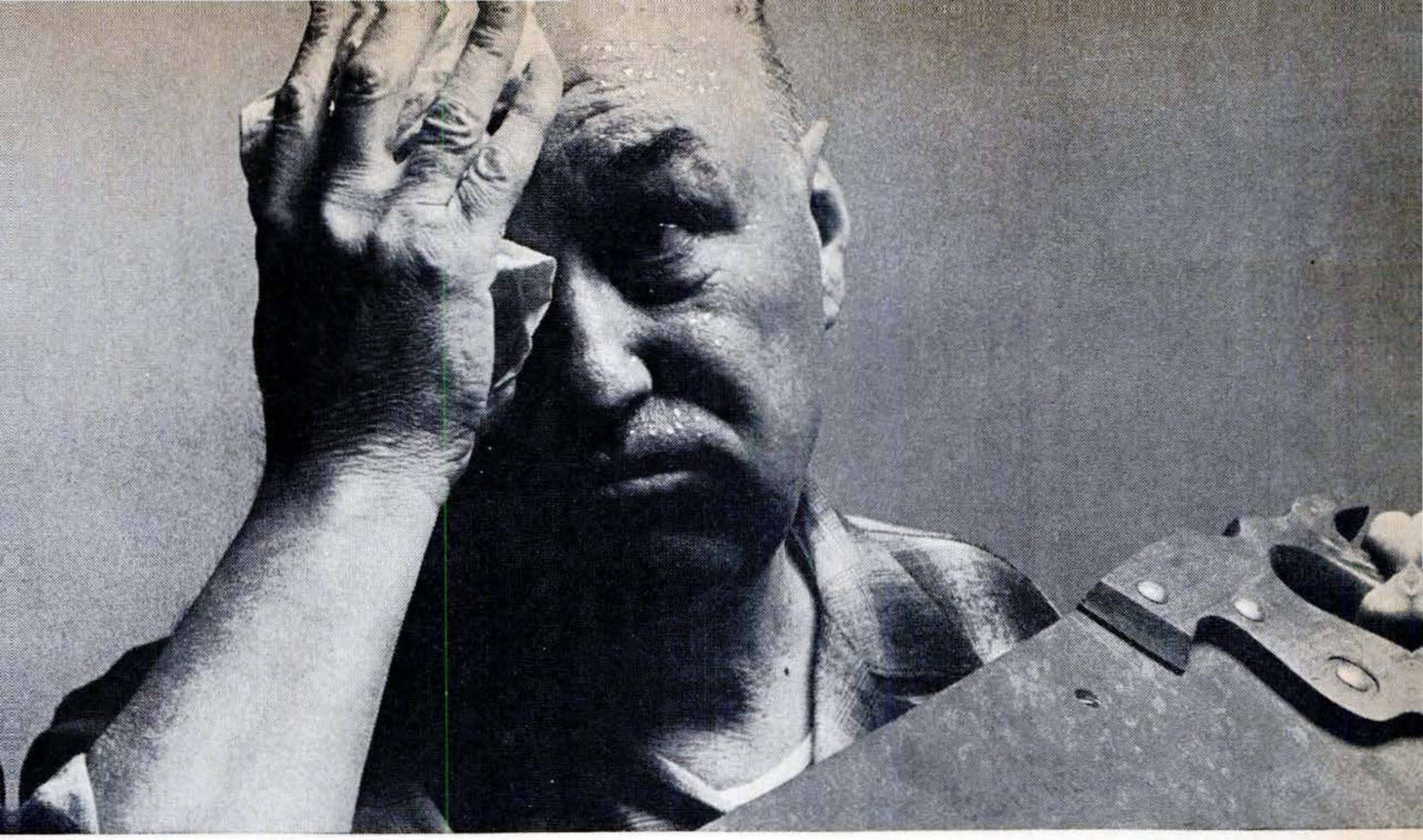
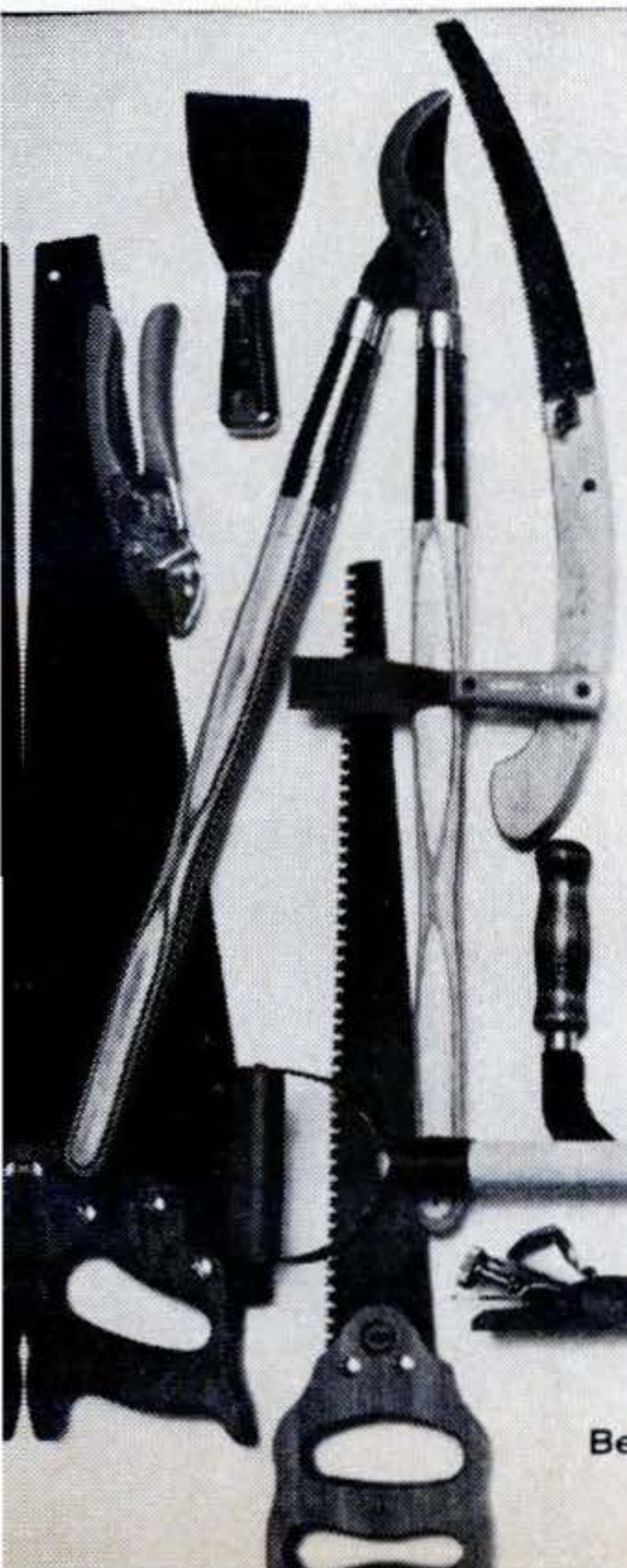


If you're not working with tools coated with TEFLON-S*

DuPont approved finish
TEFLON-S
self lubricating, no stick, easy clean, no rust

you're working much too hard.



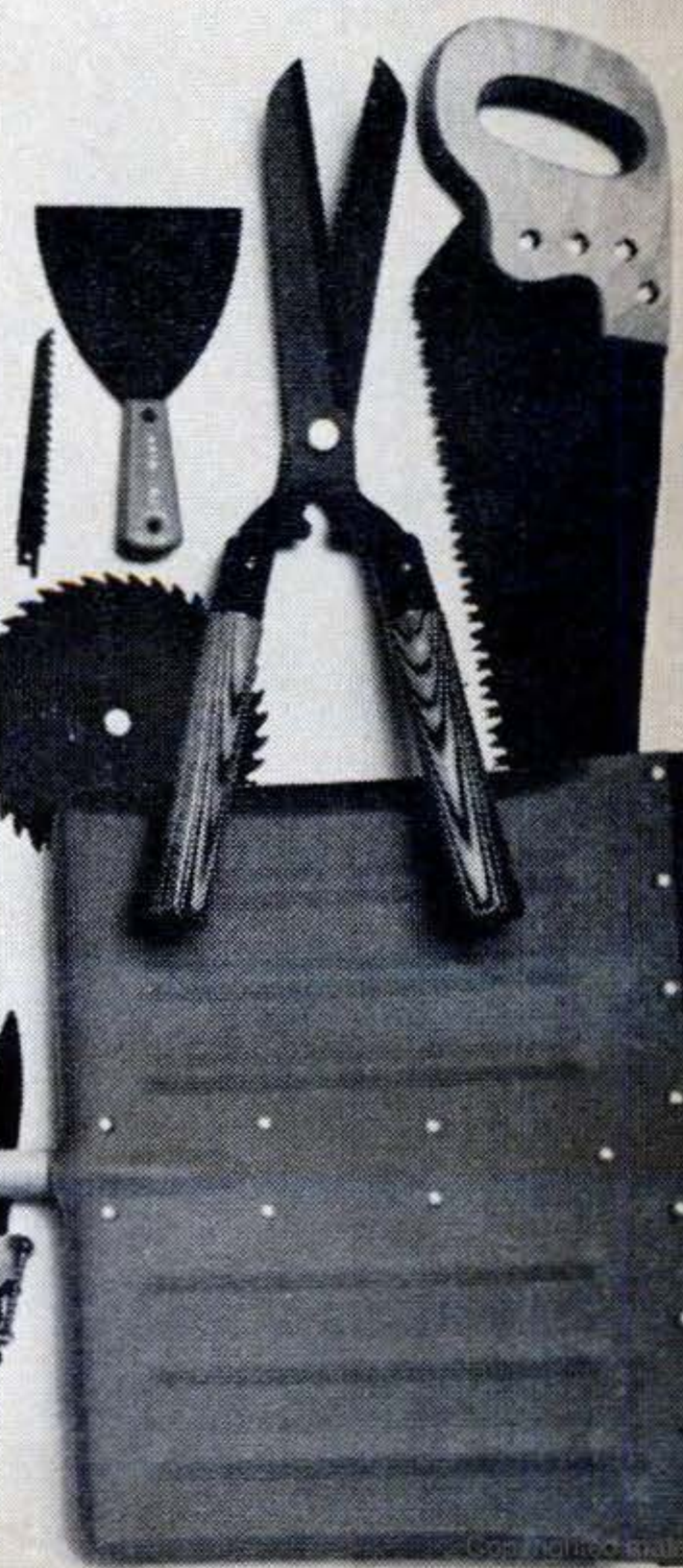
The friction-free magic of TEFLON-S means handsaws don't bind, putty knives don't drag, pruning shears don't gum up, snow shovels don't let ice and snow build up and power saw blades last longer and cut cleaner. They all clean up like a snap, and resist rusting.

TEFLON-S lends the same ease to grass clippers, anvil pruners, hedge trimmers, wall scrapers—and who knows what next?

When you see the TEFLON-S Quality Seal on a tool you know that the coating definitely contributes to its performance, and that the coating meets Du Pont's tough standards. You can have confidence in it even before you use it.

Look for the TEFLON-S seal on tools in your hardware store.

*Reg. U.S. Pat. Off. for Du Pont's non-stick finishes.



DU PONT
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Better things for better living...through chemistry

without the other tools interfering. The scroller was elevated so work can pass over the shear. I also mounted the larger accessory scroller adjoining this, placing it at an angle. For use, the workboard can be clamped to my bench.

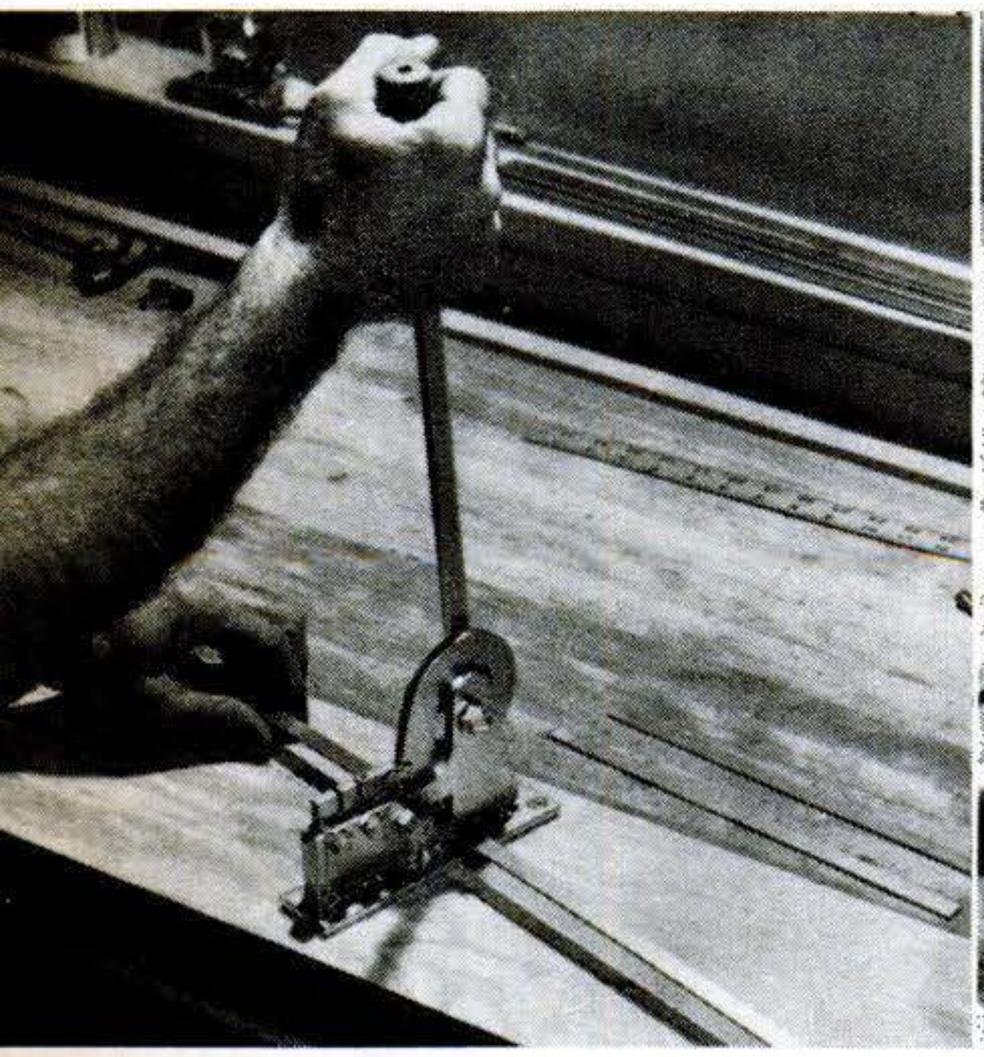
Mild steel is usually sold well oiled to prevent rust. So your first step should be to wipe it clean with mineral spirits. Use a metal scriber to mark the metal for shearing or punching.

You can work freehand if you prefer, but you may find it helpful on your first project to copy the scaled pattern on a large sheet of paper, using 1″ squares. You needn't be too concerned about sketching a work of art because graceful curves will form automatically in the metal. Do concentrate on accurate overall dimensions, however.

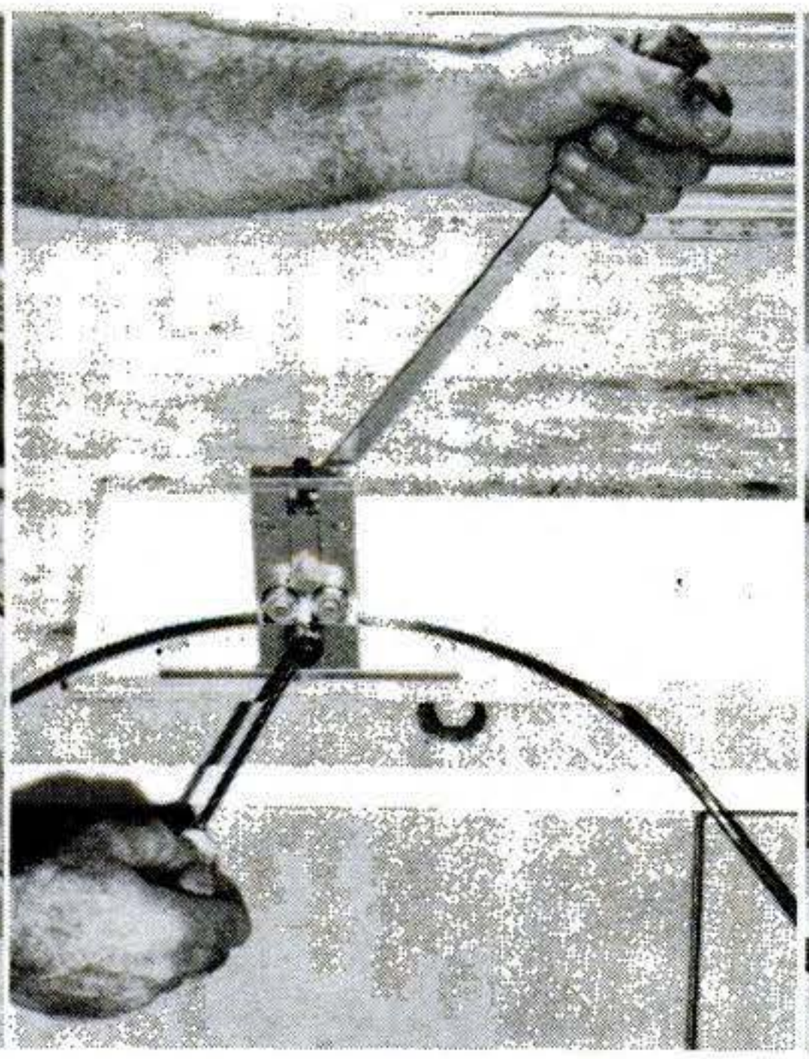
Making the telephone shelf. To make the frames for the telephone shelf shown, make a mark 10″ in from each end of the 50″ strips, and place the strip between the rollers at one 10″ mark. Applying slight pressure with the lever, rotate the roller handle to drive the metal strip through the tool, starting at one mark and ending at the other. This will produce a curvature in the metal. By applying more pressure and rotating the handle in reverse direction, the strip will

Continued

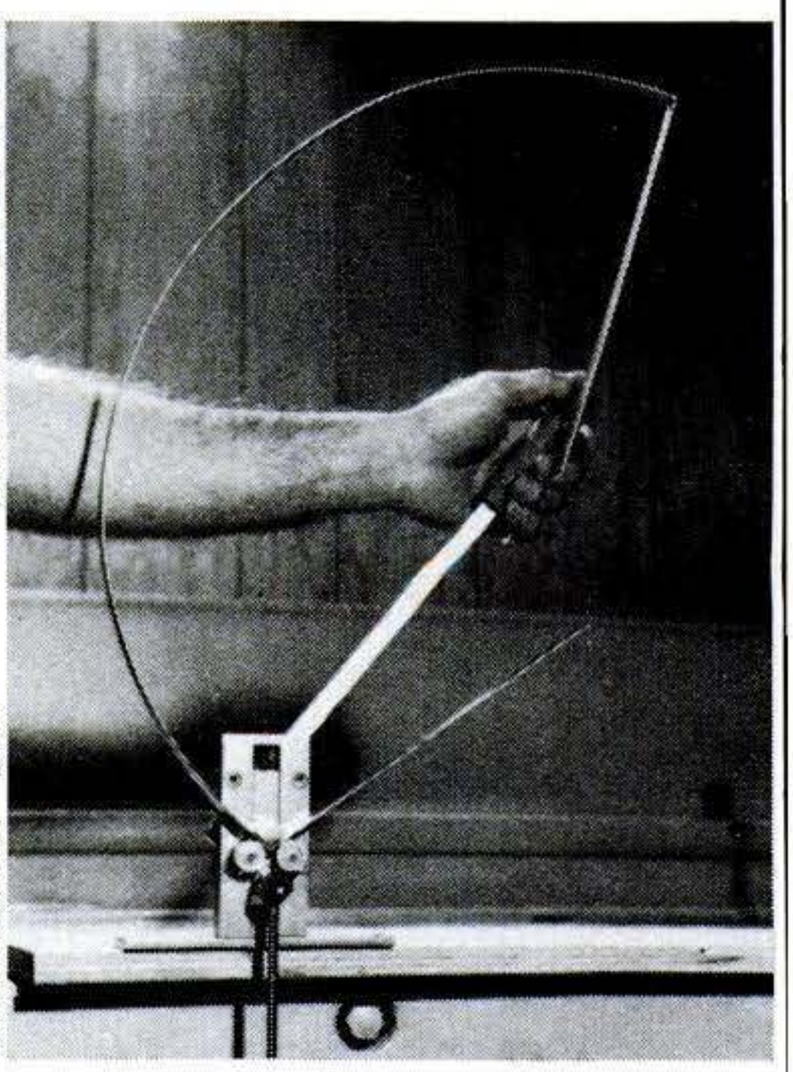
How to make the wrought-iron telephone shelf



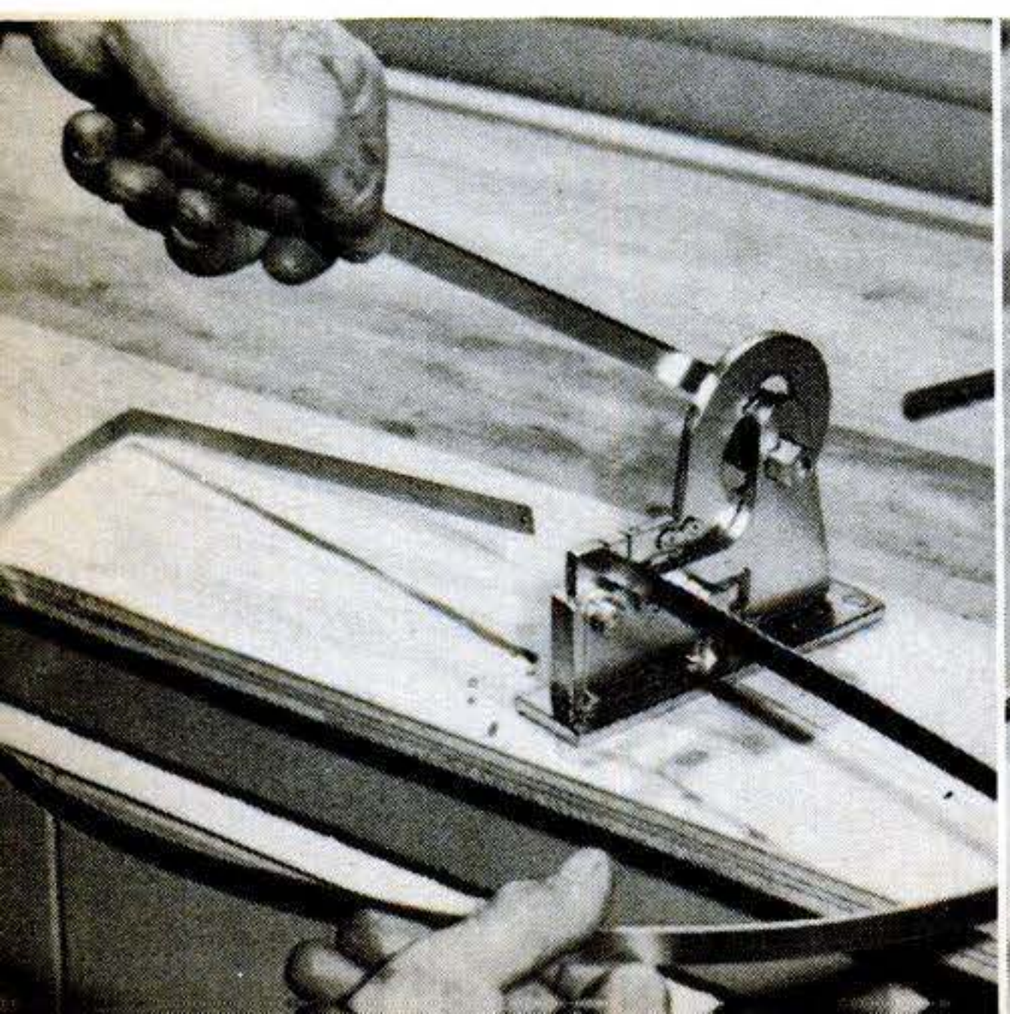
1 **Downstroke** of lever arm makes quick work of shearing metal strips to desired lengths. Angled shear lets long strip clear.



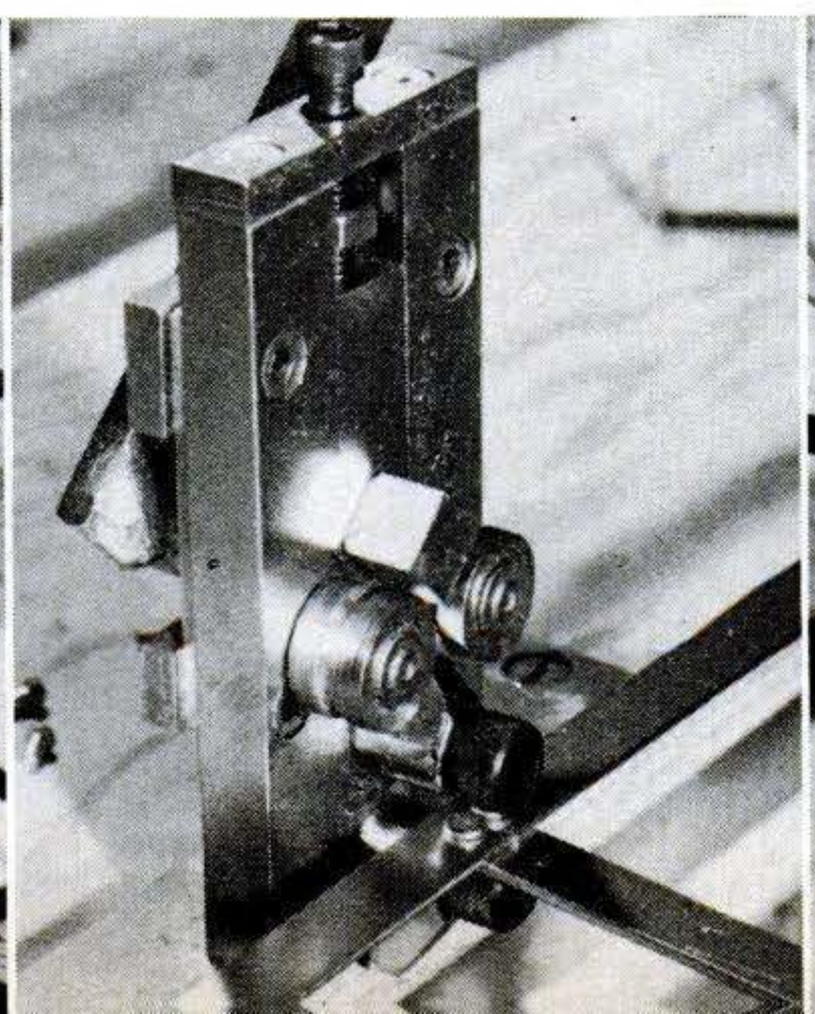
2 **Curve metal strip** by cranking roller handle as you apply light lever pressure. Adjusting screw sets to duplicate pieces.



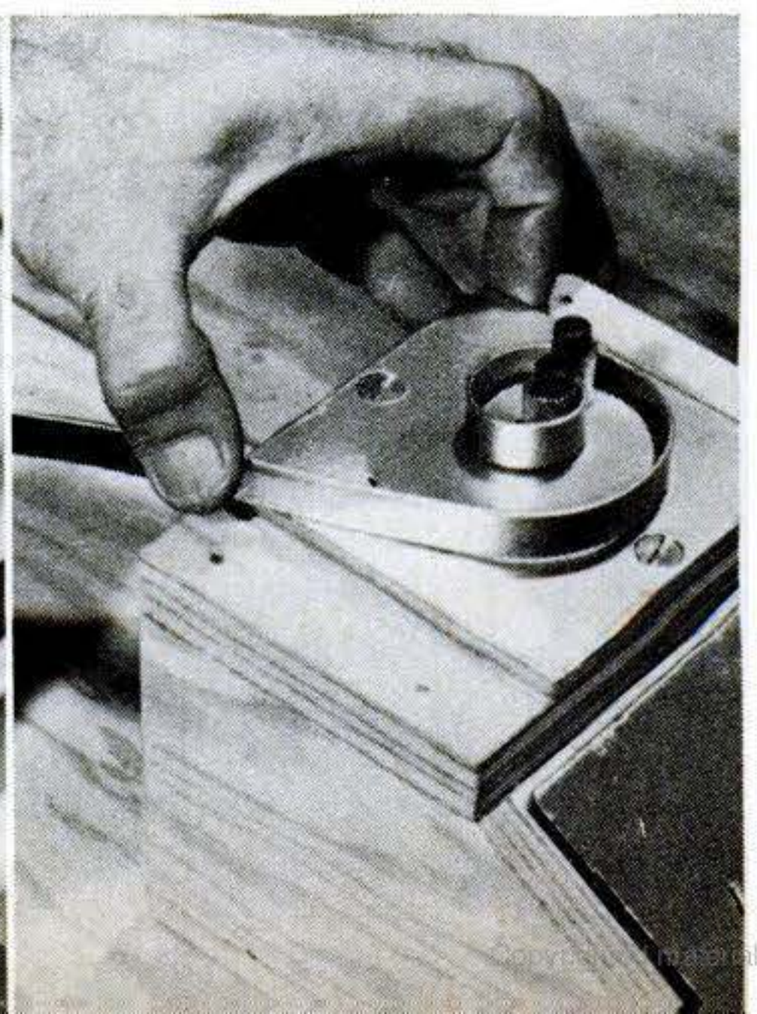
3 **Right-angle bends** are made with metal between square former and rollers. You can bend to 90 degrees. Use light pressure.



4 **Clean ⅛″ holes** are punched with metal in slot of punch aperture, pressing down on lever. Holes are automatically centered.



5 **Metal parts** are riveted as shown below. Knurled riveting anvils are substituted for the bending-roller handle to do this.



6 **Scrolls are made** by wrapping the steel strip around the scroll former. A larger scroller can be bought as an accessory.

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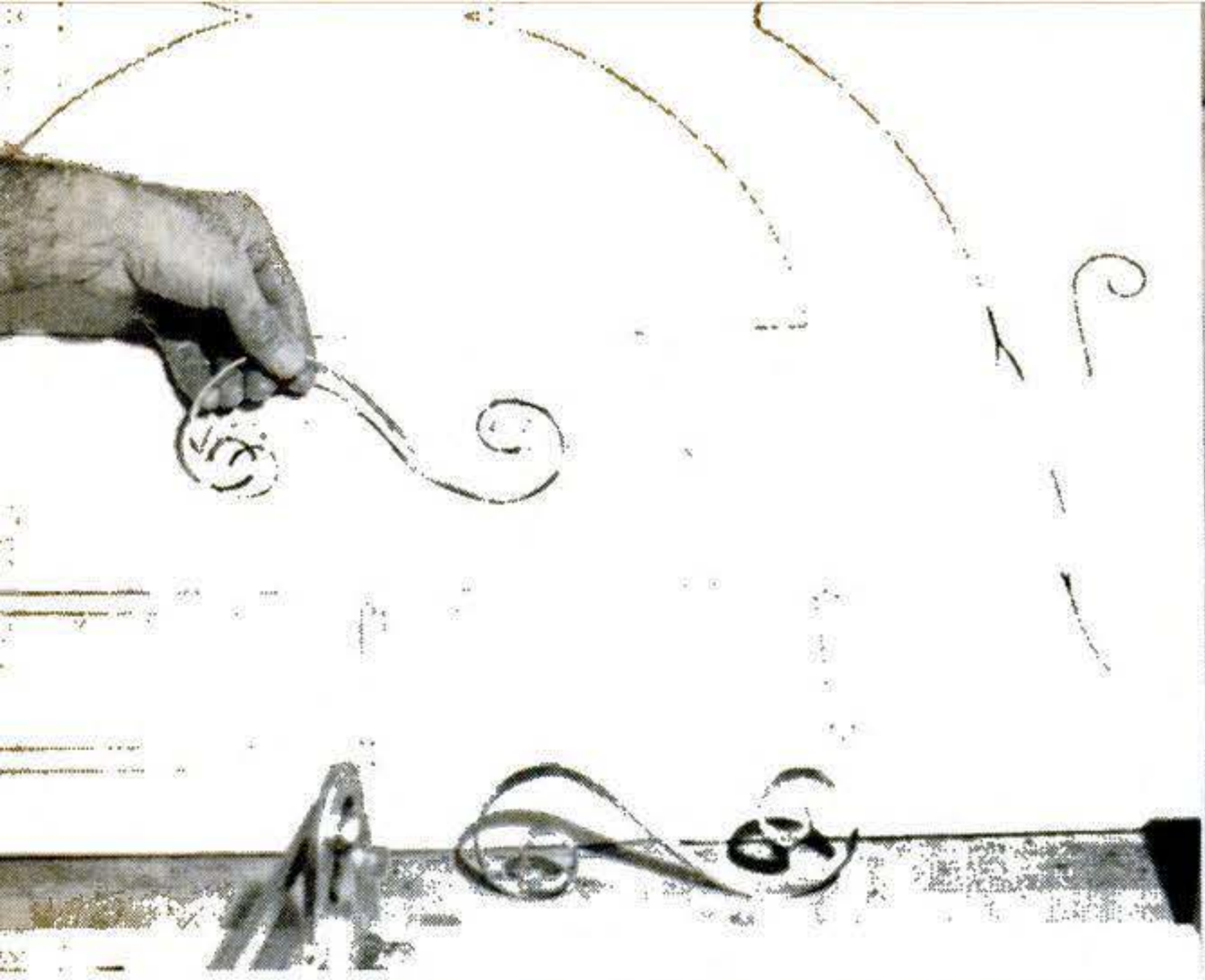
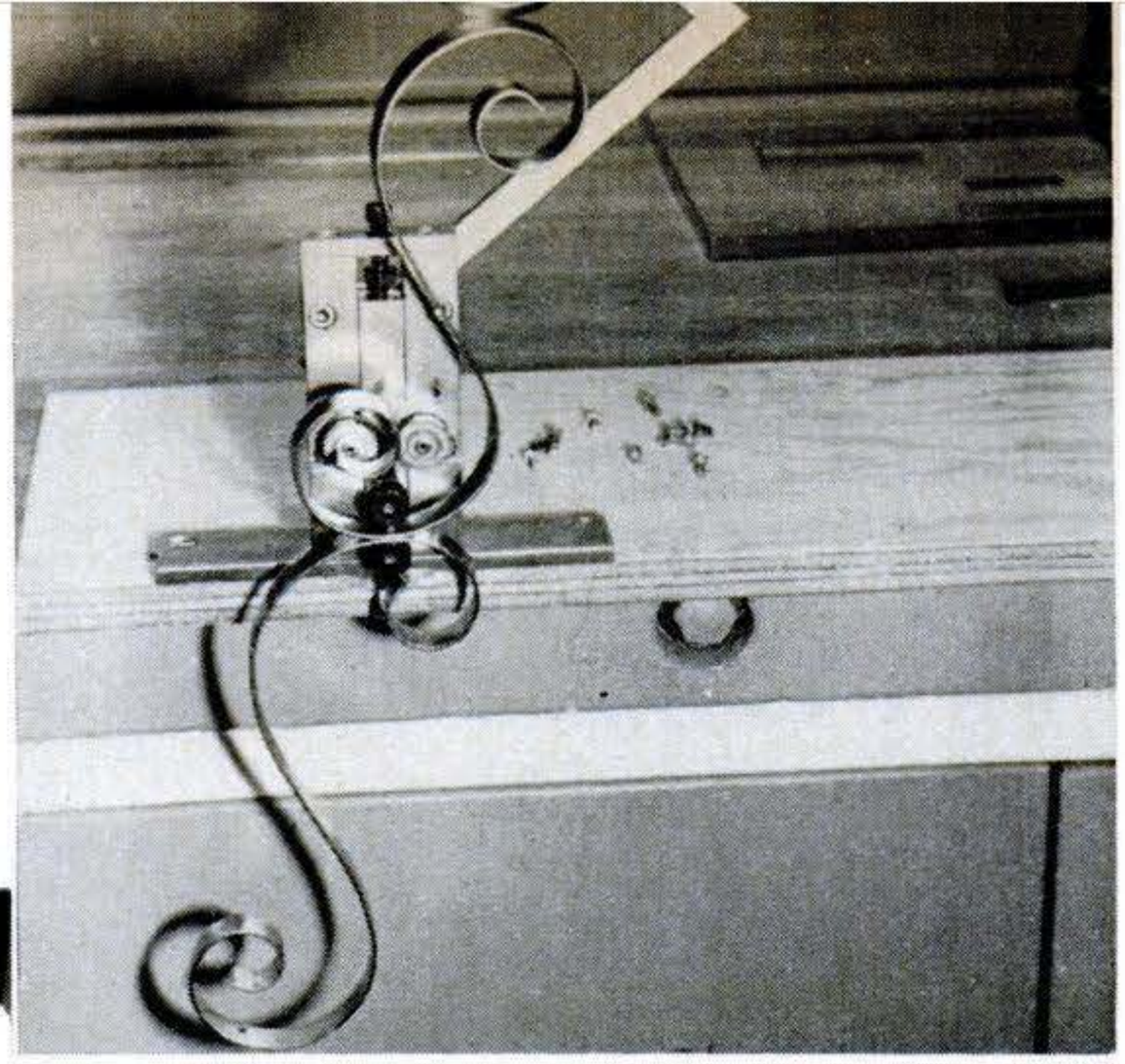


7 **By scaling up full-size patterns** from drawings, you can check pieces for accuracy. Lower sketch shows assembly at rear of shelf.



8 **After making four scrolls,** lay them end to end, punch matching holes in each so all four can be riveted together. Place 20″ scrolls at center.

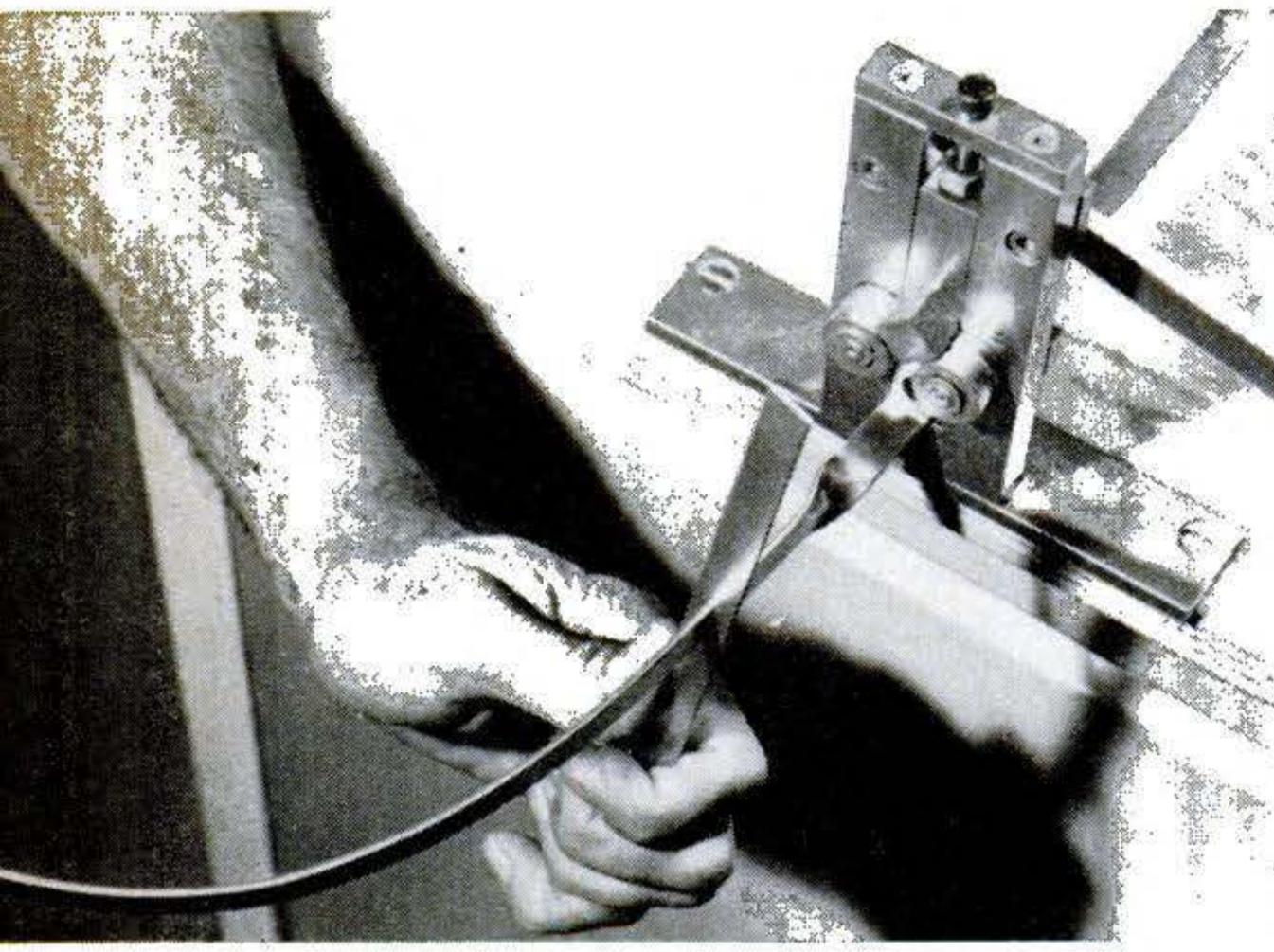
9 **Scroll assembly** must be curved to conform to curved front of the phone shelf. You can achieve this curvature easily around a metal can.

return through the rollers and produce more curvature.

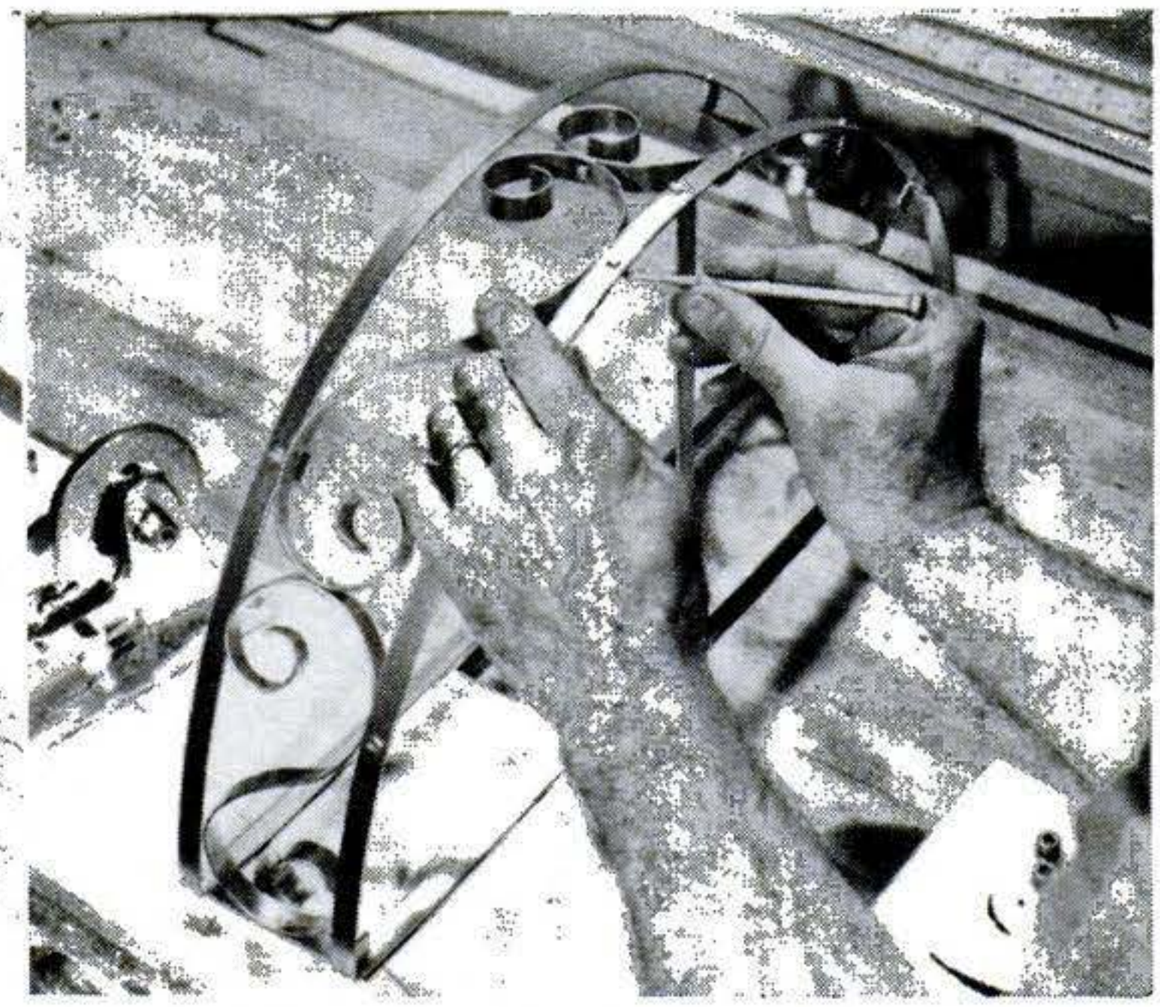
Now place the scribed marks between the "square-former" block and the two fixed side rollers. Apply pressure on the lever to bring the former down on the marks to produce neat right-angle bends. Punch holes in the ends and rivet the two semicircles to the main bracket, using ⅛″ rivets ¼″ long. Note that this bracket as well as the four small glass-supporting brackets are not set flush with the top but instead are positioned ⅛″ below the top edge of the frame.

This offset is necessary so the ⅛″ plastic top will lie flush. The punch makes holes in the center of a ½″ strip but an accessory metal piece supplied with the

Continued



10 **A twist is required** in supporting bracket below shelf assembly. To do this, make a twisting wrench by punching holes in strip.



11 **Holes for attaching the scrolls** to small L brackets are marked directly through holes in the brackets against proper spots on scrolls.

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kit enables you to punch holes offcenter when required. Use this piece to make below-center holes in the upper frame for the glass-supporting brackets.

For riveting, the rolling handle is removed and two riveting anvils are inserted into the bending tool. Slight pressure on the lever closes the anvils over the rivet to deform it. Four scrolls are riveted in tandem to make up the ornamental front. You'll find this operation quite easy. Insert the strip end between the knurled posts, then pull the strip to "wrap" it around the raised scroll form. Check the scrolls against the drawing to duplicate the designs accurately.

Making a curve. When the scrolls are completed and connected end to end they obviously will not conform to the curved front of the table until they too are bent into a curvature. This is readily done by placing the unit over a curved surface such as a round pail. Slowly, by trial and error, bend the scroll unit into the required curve. Check constantly against the table front until it conforms. Mark off the scrolls and the upper and lower table frame at the junctures of the "high" spots, and punch holes and rivet the attaching brackets.

You will note that when you reach a certain point, the shape of the workpiece won't fit into the riveting anvils. This will occur on several of the L brackets. At this point you have the choice of using nuts and bolts supplied with the kit or riveting with a hammer on a separate pounding block.

Curves are rolled in the supporting bracket in the usual manner to produce a slender S. You must then produce a twist in the midsection. You can do this by making a special wrench. Take an 8" strip of metal and punch a series of holes close together to make a slot just over ½" long. Support the workpiece in the space below the sliding block of the bending tool, insert the wrench, and twist it through 90 degrees. Reposition the work 4" back and repeat the twist. The two half-scrolls are attached with an ⅛"-by-⅜" rivet.

A clear-plastic top cut to fit winds up the construction. Make two holes at the back of the upper frame and one on the supporting bracket to attach the shelf to the wall. PS

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LGC LIFE GUARD CONSTRUCTION

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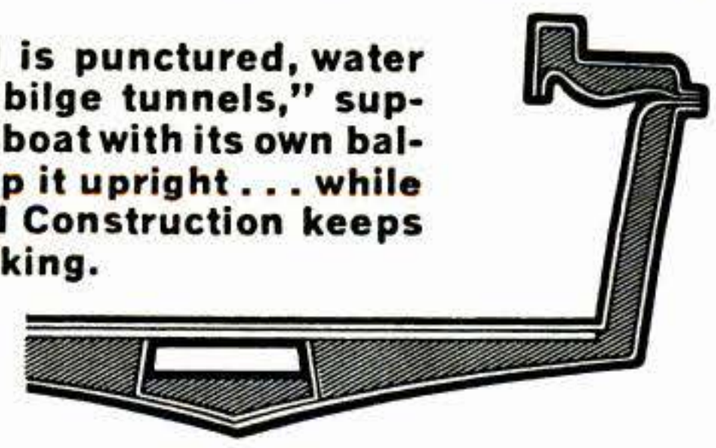
Life/Guard Construction makes fibreglass boats *safer, stronger* and *quieter* than ever before. It's an entirely new way of building boats.

Most modern hulls consist of layers of fibreglass bonded together. Flotation is provided by blocks of plastic foam and by an air chamber in the bottom. Some types of foam can become waterlogged and ineffective. And because most buoyancy is in the bottom, a boat filled with water tends to capsize.

If the hull is punctured, water fills the "bilge tunnels," supplying the boat with its own ballast to keep it upright . . . while Life/Guard Construction keeps it from sinking.



Here's how Life/Guard Construction is different: a new kind of foaming plastic becomes an integral part of the boat. It soaks up sound and vibration but can't soak up water.

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It's quieter because the foam deadens water and engine noise instead of transmitting and amplifying.

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Glasspar 18′ Cutlas

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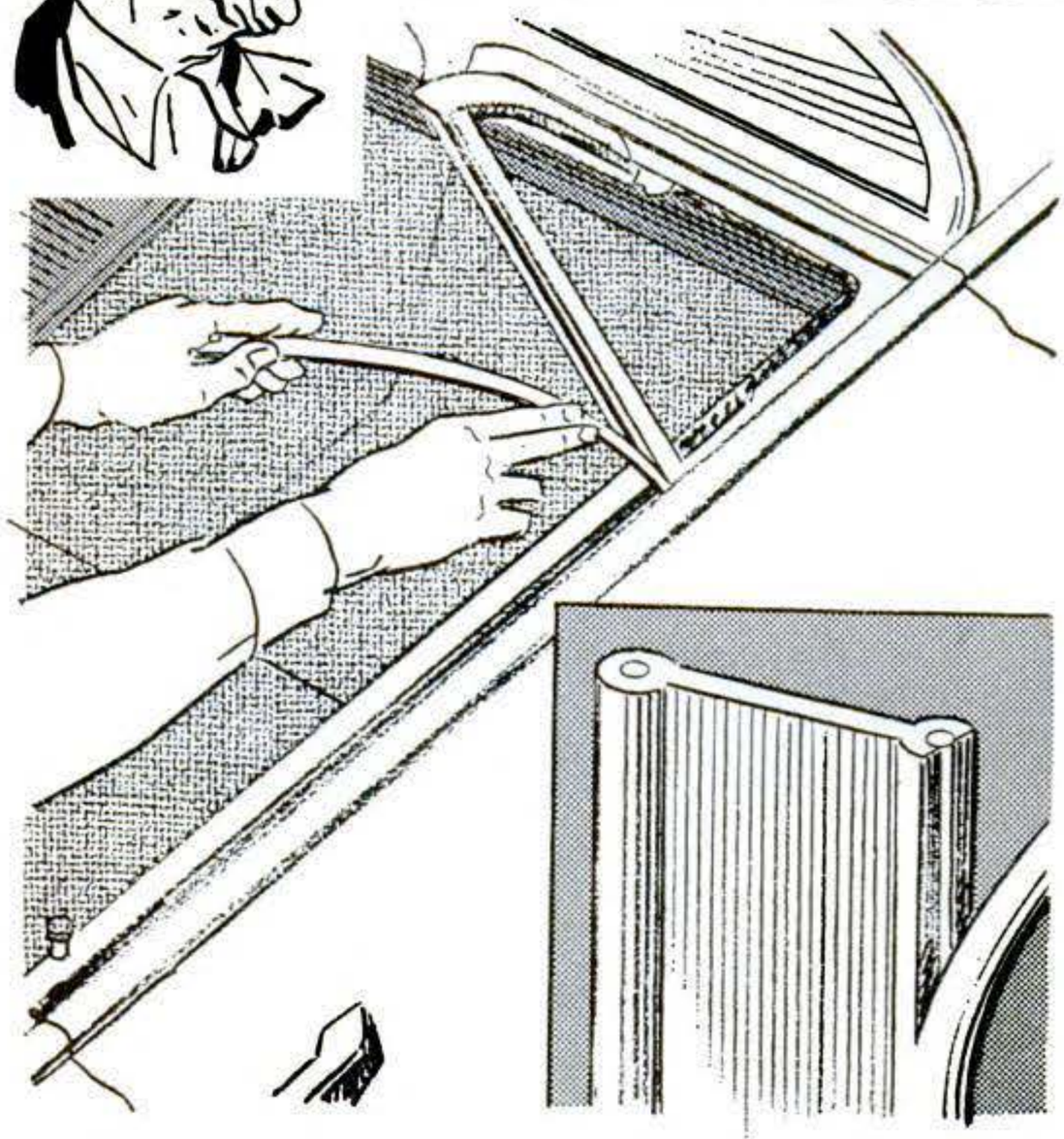
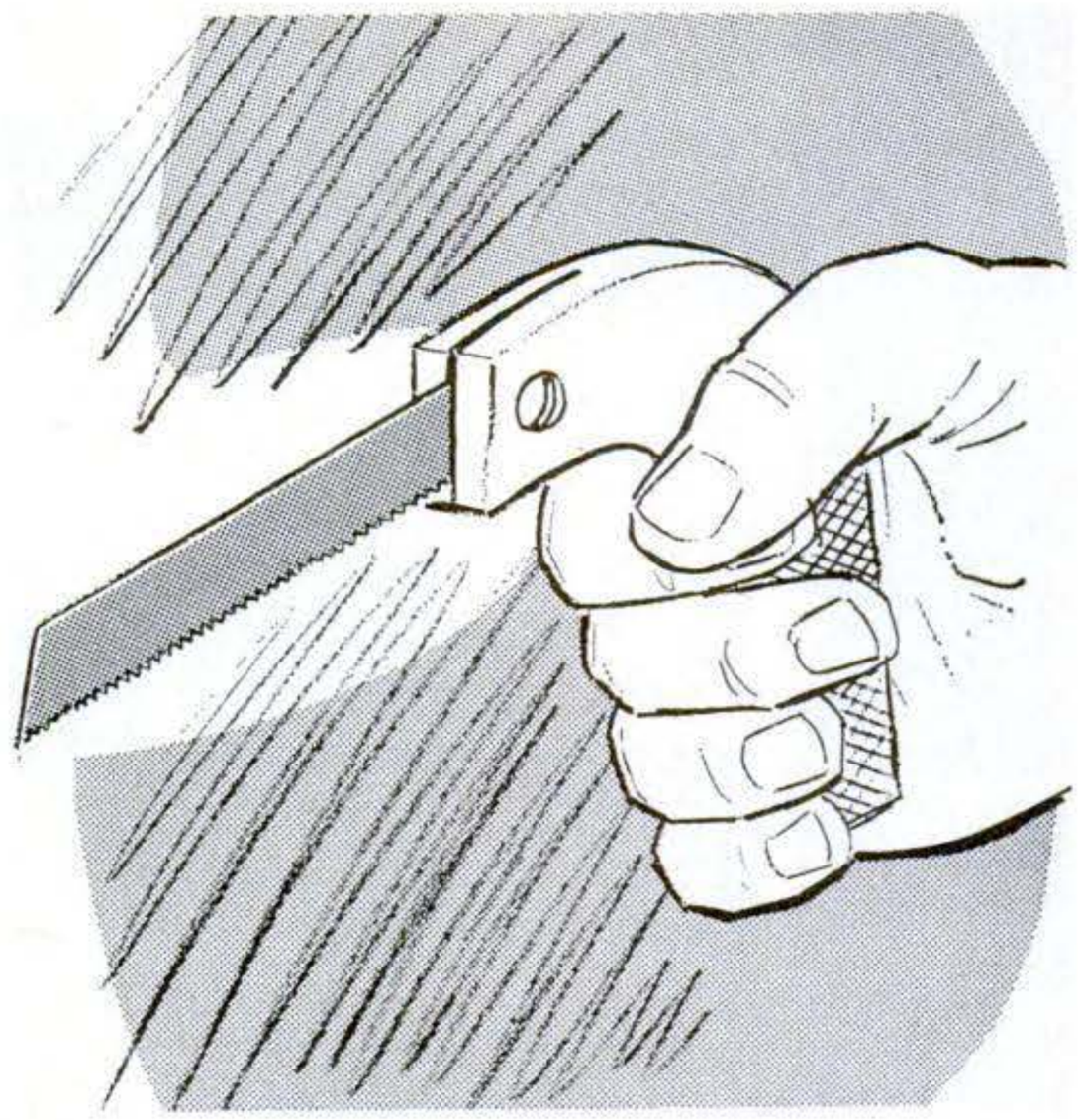
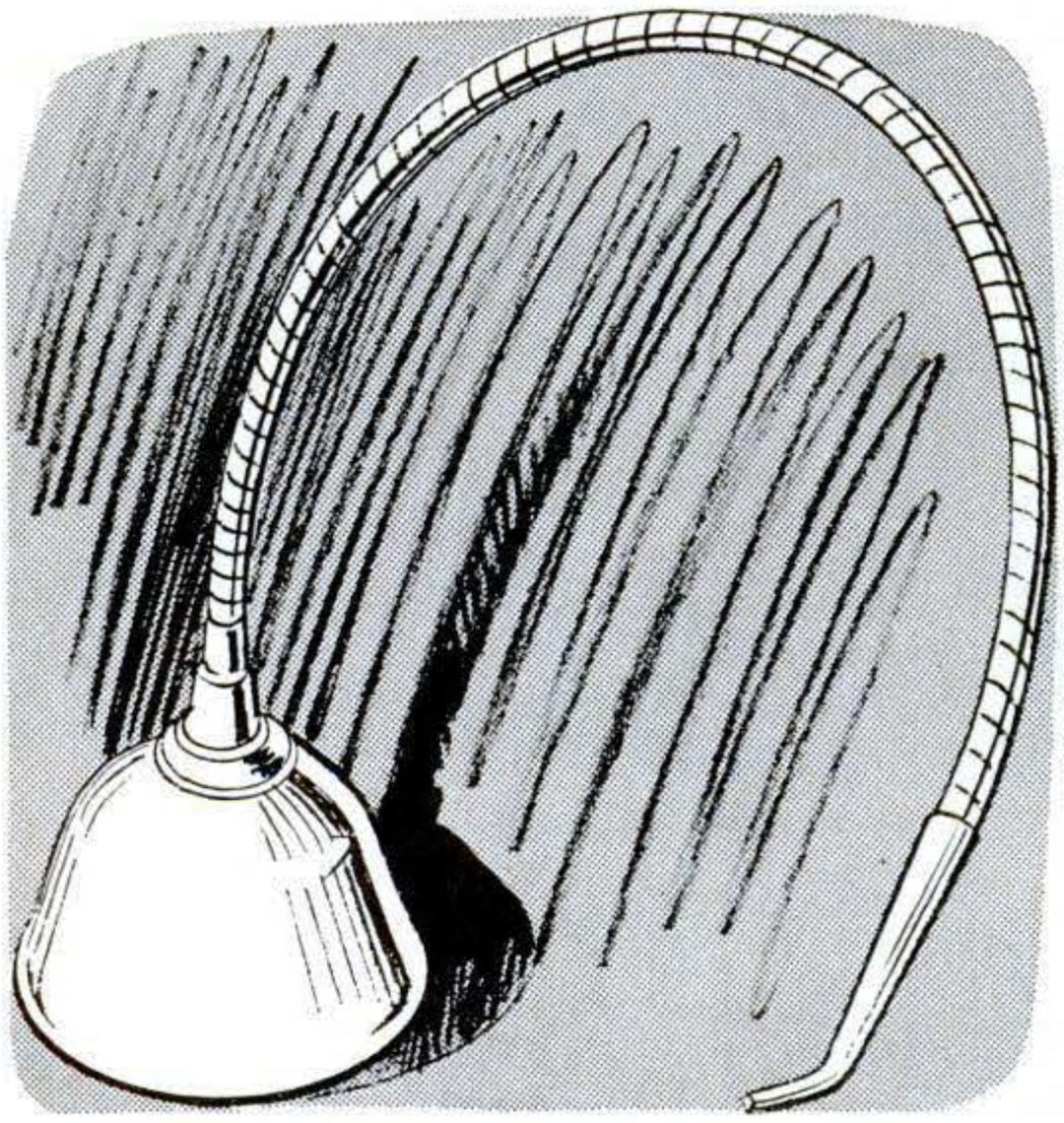
Hints from the Model Garage



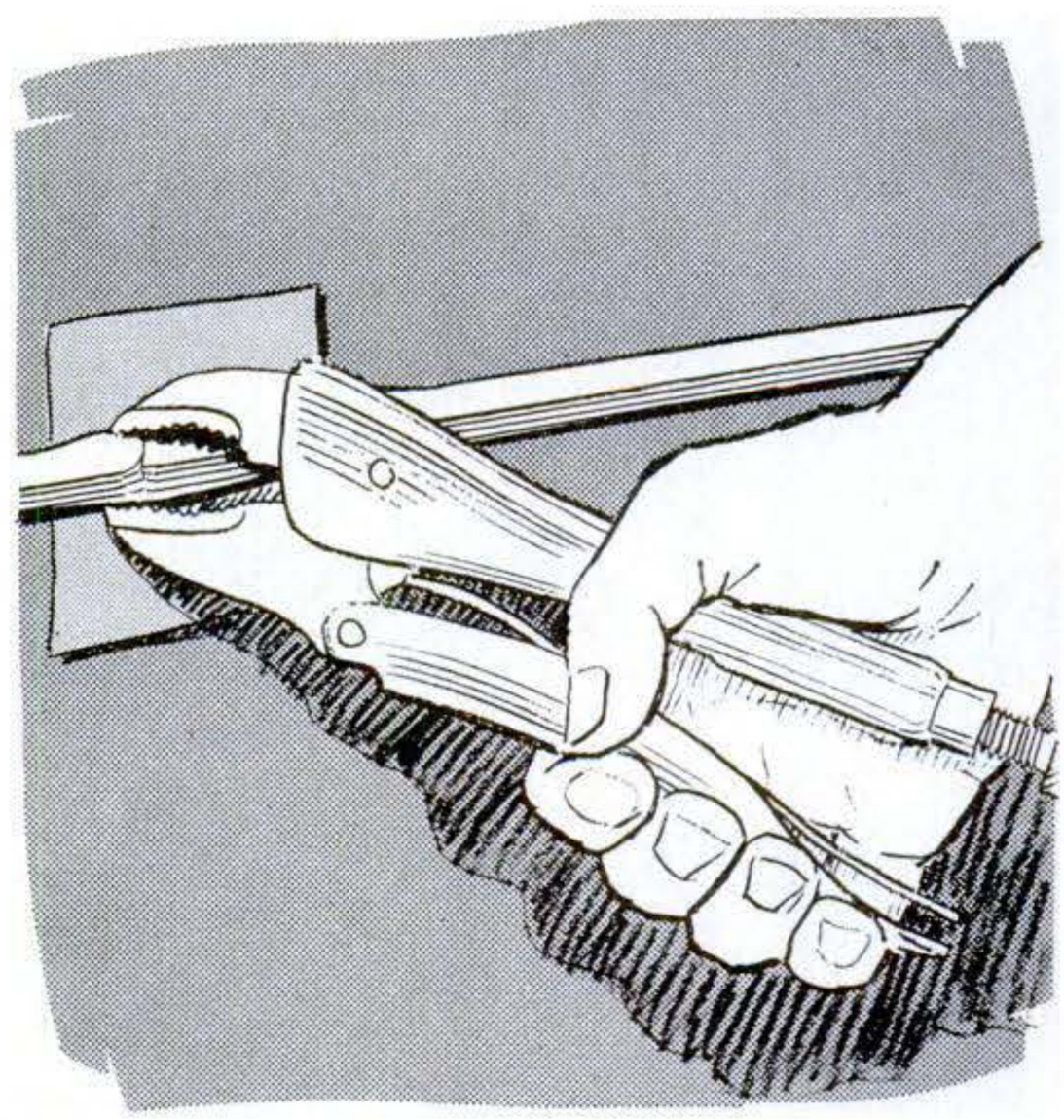
Stop window rattles the easy way. With the window down, push a piece of flat TV lead-in wire, 20 to 30 inches long, into the guide channel. The plastic coating will keep it in place. If the fit is too tight, shave a little bit of the plastic off one side of the wire.



An old keyhole-saw handle can be fitted with a broken hacksaw blade to make a handy tool for undercutting the commutators of starter-motor and generator armatures. Grind the blade as shown in the drawing, and insert it with the teeth pointed *towards* the handle.



A flexible extension for your oil can is easy to make. Next time you replace a speedo cable hose, save a foot of it at the instrument end. Then cut the tip off an oil can and solder or cement one end of the hose to the neck, the other to the tip. Presto—a gooseneck oiler.



Dents in chrome molding on car doors or fenders can be removed easily. Use a plier wrench to squeeze the molding back to original shape, after inserting a small square piece of masking tape or thin cardboard between sheet metal and trim to protect paint.

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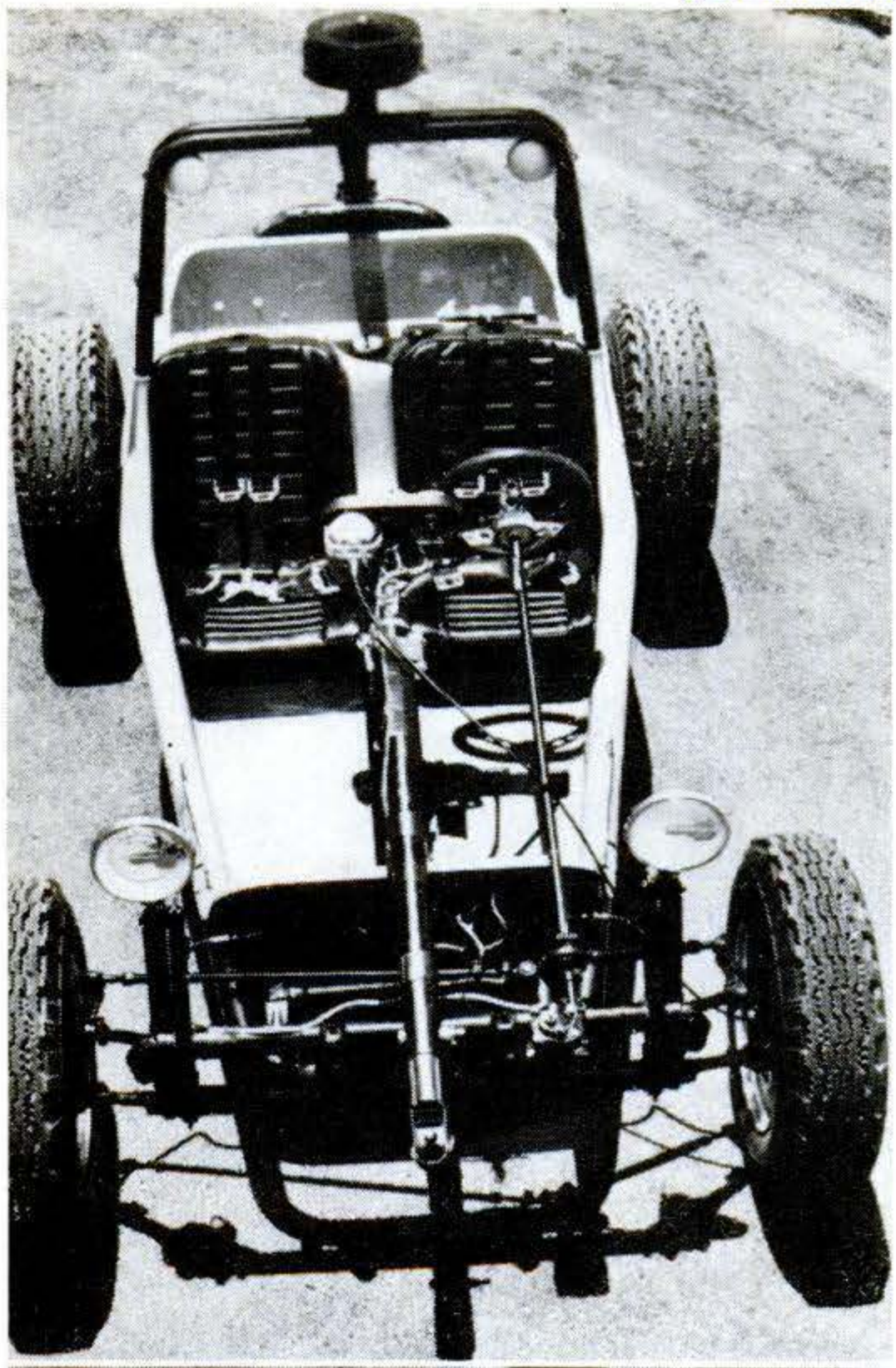

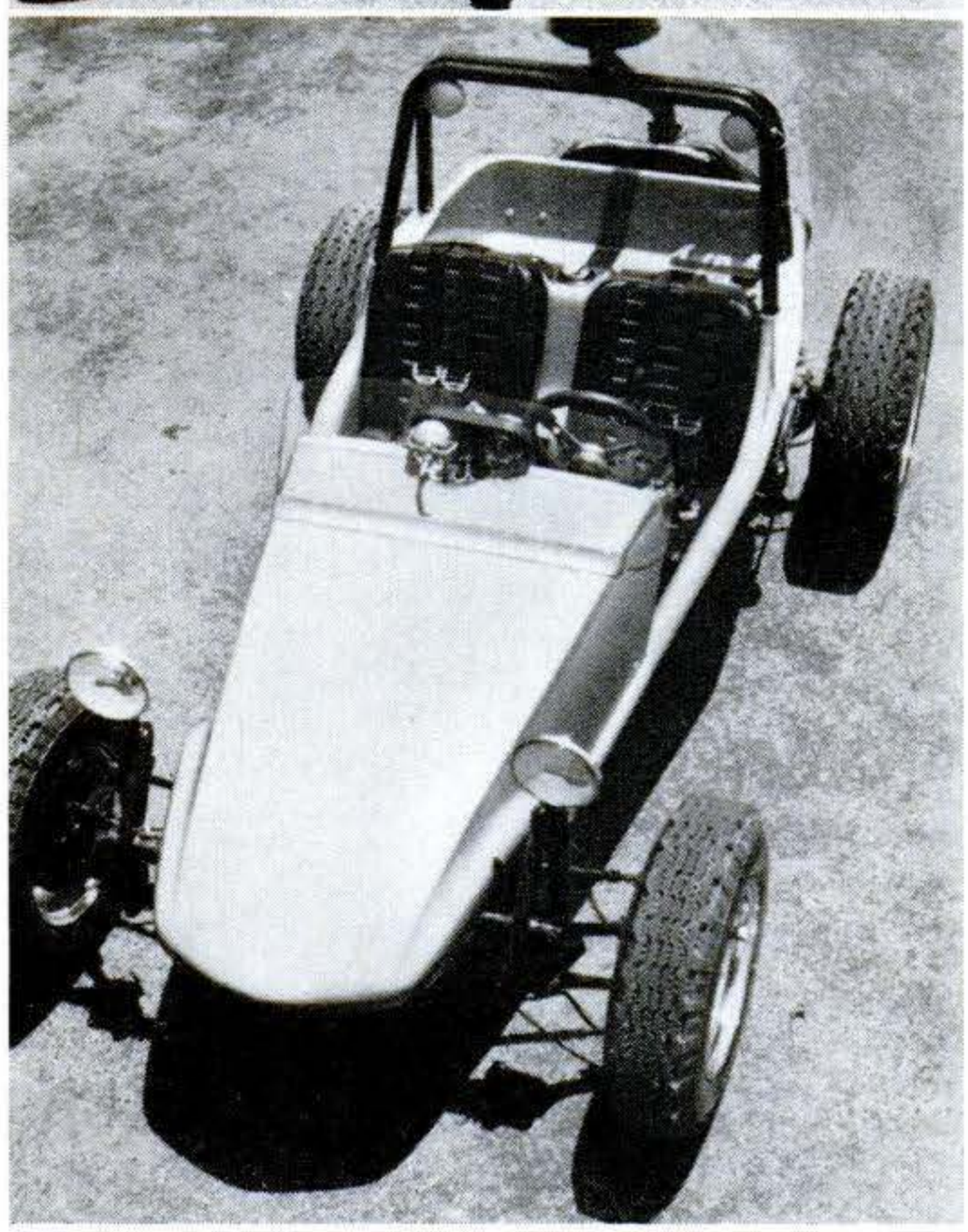

This is the Tow'd from the stable of Bruce Meyers—probably the biggest producer of fun cars in the world. Meyers' latest model, it supplements the older Manx. The Tow'd is a stark, ultra-lightweight two-seater designed to be suitable for competition.

many, some are hiding). Increased competition naturally affects pricing.

You can get started for as low as $175, for a cut-down buggy frame; or $200, with fiberglass body. A buyer going all-out can find road-ready dune buggies at from $2,900 to $4,000.

Straws in the wind. Rumor has it that Meyers-Manx has a deal to handle the Ford V-4 engine and Ford transaxle exclusively in their field. There is room to speculate that the availability of the V-4 may nibble away at VW, Porsche, and Corvair engine domination.

Registration problems can be quite complex. In California, for example:

1) You locate a wrecked VW and take its license and registration certificate to the Department of Motor Vehicles.

2) You're issued a "suspense receipt."

3) After completing the buggy, you take it to the DMV with the bills for all parts and your suspense receipt.

4) The DMV then registers it in a new special-vehicle class with no brand name. Fees are based on retail value.

Prices for a wrecked VW range from a low of $150 for a '55 to as high as $850 for a '67. Since 500,000 new VWs came into the U.S. in 1968, cars and parts will be around for a long time.

Is Volkswagen of America interested in this slice of pie? They've played the dune-buggy fad very cool; but in late 1968, a questionnaire went out to buggy builders to determine possible markets for components. Now there's a rumor that Volkswagen of Mexico is prepared to sell preshortened *new* frames.

Supermart buggies next? According to inside sources, J. C. Penney is preparing to enter the dune-buggy market with an all-new chassis and engine made in Japan. The plastic body will be made here. Plans call for new-car warranty.

How to spot a cheapie. A low price is not necessarily proof of low quality, but it is a clue. Most companies offer two or more models to compete more effectively. Whether you choose the economy or deluxe model, watch for signs of inferior workmanship. Check these details:

- Quality of finish. Viewed along the sides against the light, a high-quality fiberglass body will be nearly free of rip-

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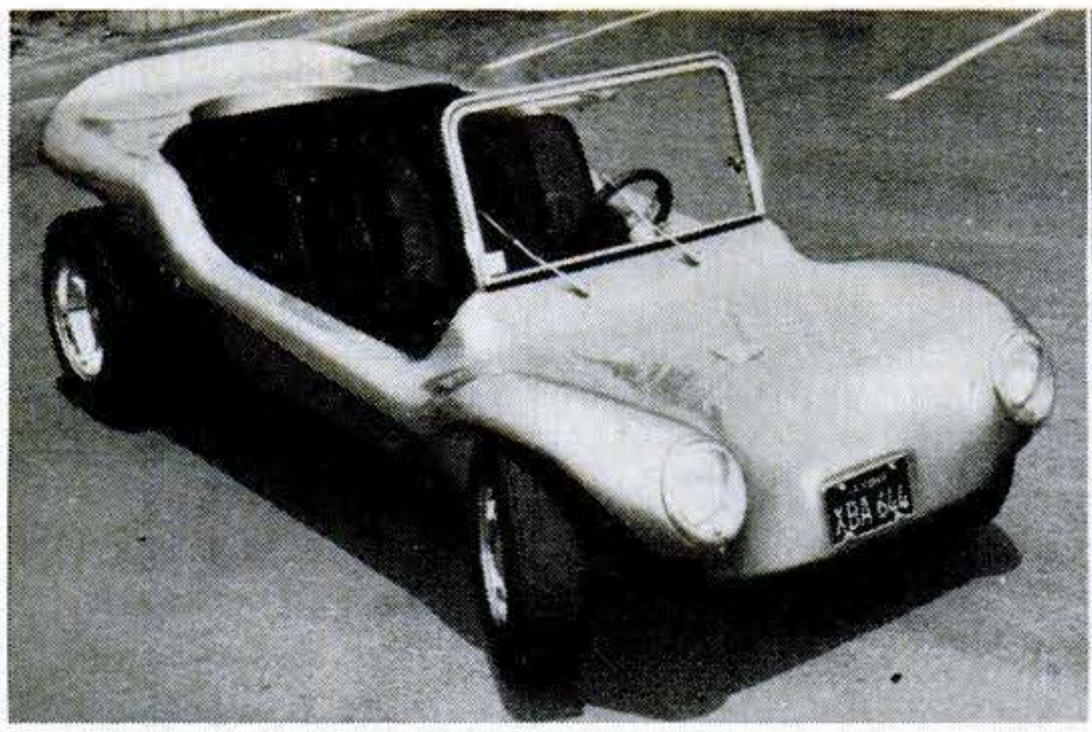
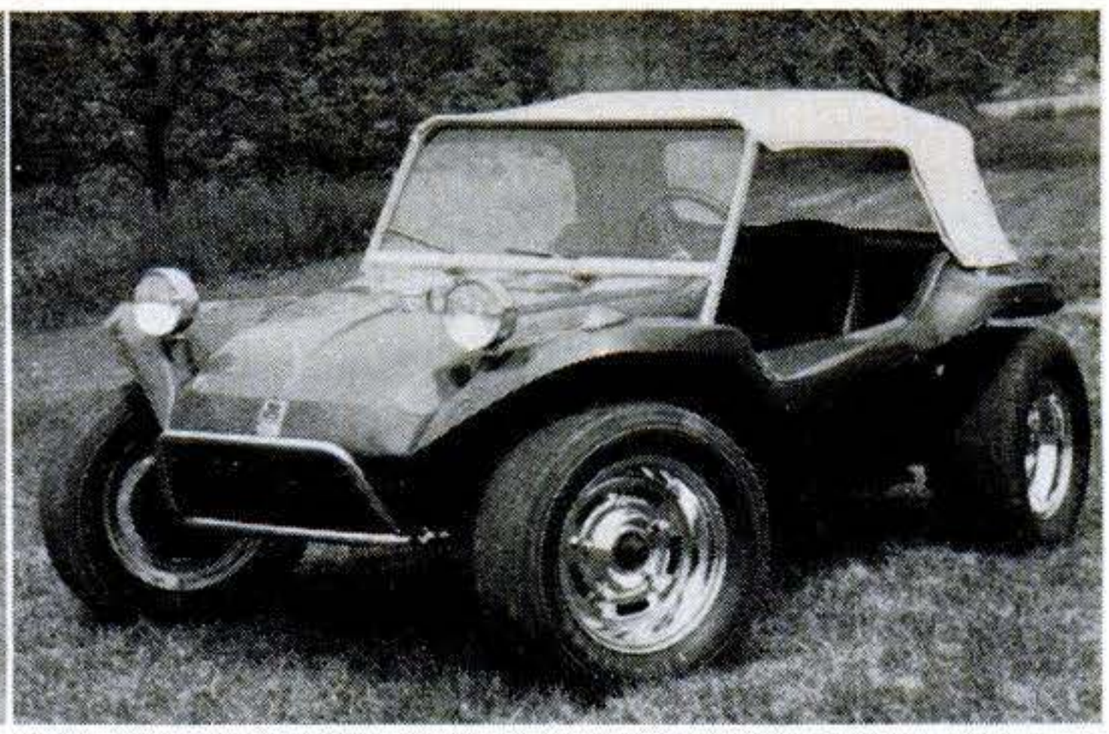


Fun Hugger is a civilized four-seater and one of the more expensive models you can buy. A checkered-flag plaque on the fender hides gas-tank cap.



Terra Buggy, a four-seater, has appeal of road-riding imports. It's intended as an off-road touring car rather than a racer, despite hot-rod styling.

ples and dimples. Cheap bodies may have wrinkles, bubbles, or even glass fibers protruding through the gel coat.

- The color should be uniform, and of high gloss.
- Thickness of the fiberglass used is important. There are no concrete rules on this, but one clue is to place your hand behind one of the body panels. Can you see the outline of your hand *through* the fiberglass? A see-through finish is thin in spots.
- The construction process can be hand lay-up, or sprayed-on chopped fibers. Properly done, both methods are satisfactory. Improperly done, either method can result in an inferior body.
- The weight of a fiberglass body is a strong clue to strength. More weight in materials costs the builder more. Of course, how it was constructed has bearing, too, but weight is a good clue.
- Any fiberglass body should have extra reinforcing at points of stress. The more reinforcing, the higher the quality.
- Dimensions are critical, and size can vary as much as ½ inch. While most bodies are built for about 14¼- to 14½-inch floor-pan shortening (Empi Imp is one exception; there may be others), the "imitation" body can be slightly different. This creates problems when bolting it to the floor-pan frame. Obviously, if one shop makes a "splash mold" of another company's body, it will not have the same precise dimensions. Take some measurements. A lot of fitting or realignment of bolt holes might be required with an odd-size body. Is it worth it?
- If a body builder suddenly has a competitor with a look-alike buggy—beware! The newcomer may be a cheapie, an odd-size copy, or shoddy imitation.
- One way to test a body builder's business background is to ask to see his literature. If he has none, think twice.
- If the optional equipment offered is borrowed from some other maker, it means that the buggy builder hasn't yet acquired the skill or funds necessary to make his own.

Who makes dune buggies? We list 38 builders below, and prices (where known).

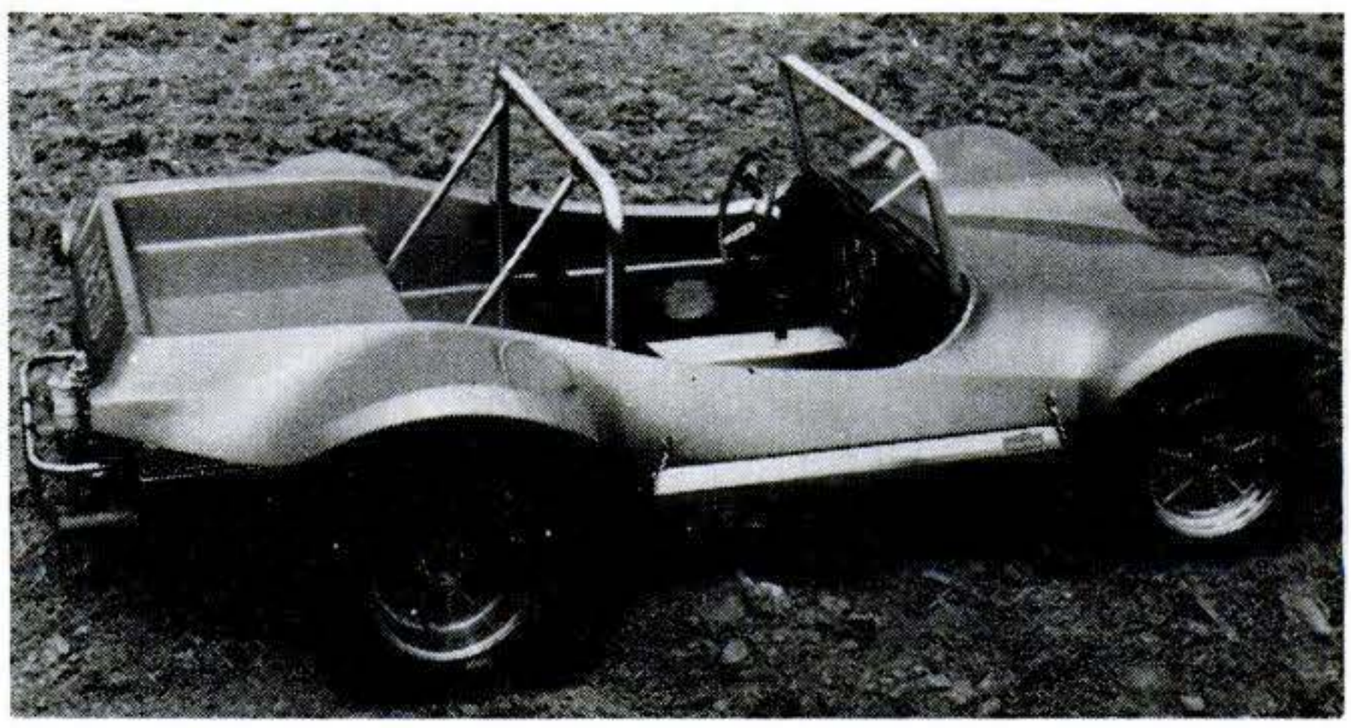
Beettle—Beettle Auto Haus, 8709 Highway 99, Vancouver, Wash. 98665.

Boon Docker—Boon Docker Buggies, 9240 Artesia Bellflower, Calif.

Buggetta—Jerry Eisert Enterprises, 1245 Logan Ave., Costa Mesa, Calif. $2,995 (complete car).

Burro—Burro Co., 1353 Santiego Ave., Santa Ana, Calif. 92701. $400 up.

[Continued on page 224]



Buggetta is one of the newest models on the market, offering a useful cargo platform behind the two seats. In its first year, it earned popularity as a racer. Hood has faired-in headlamps.

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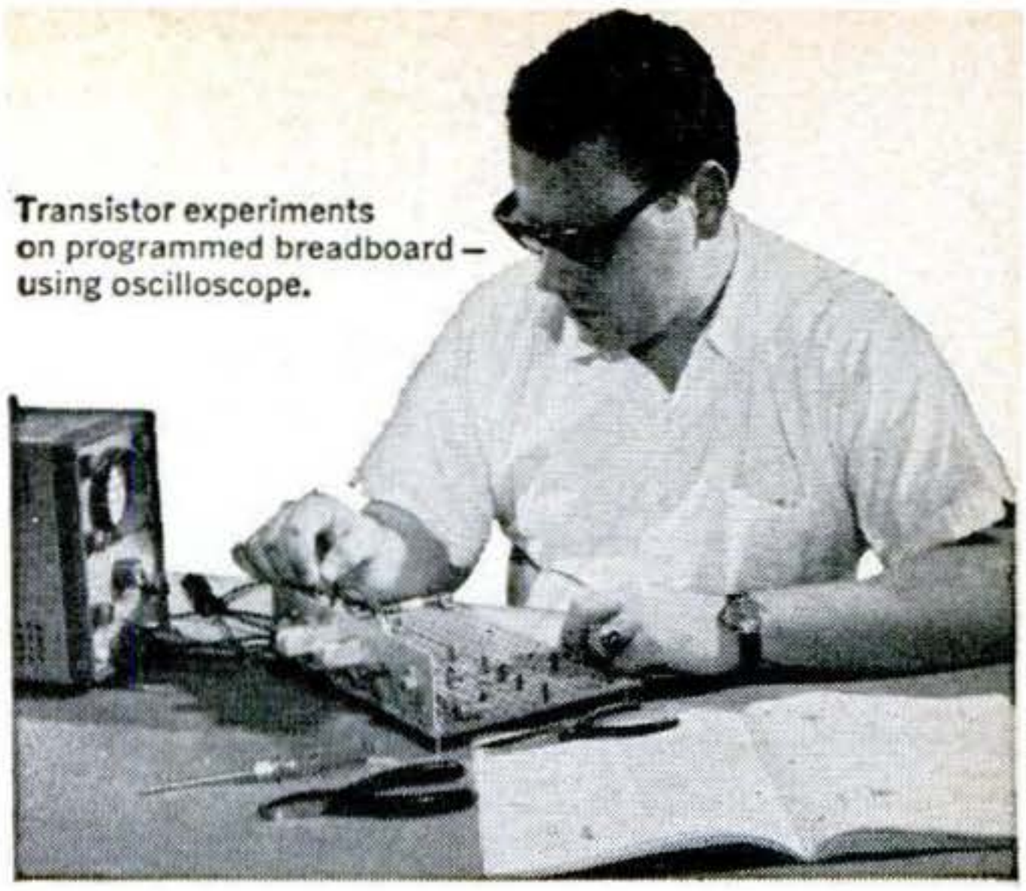

Transistor experiments on programmed breadboard – using oscilloscope.

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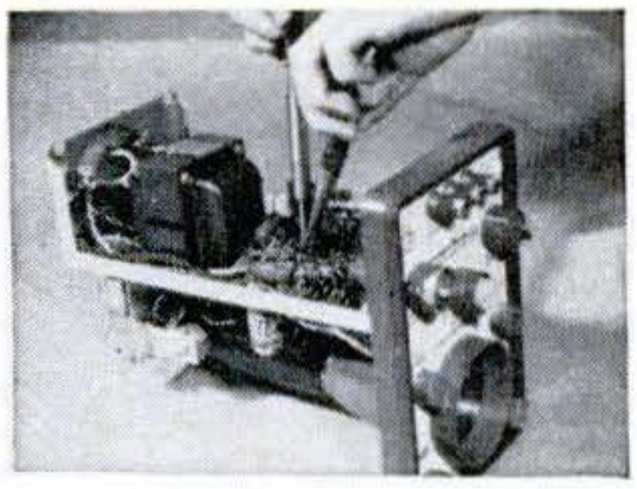

Construction of Multimeter.

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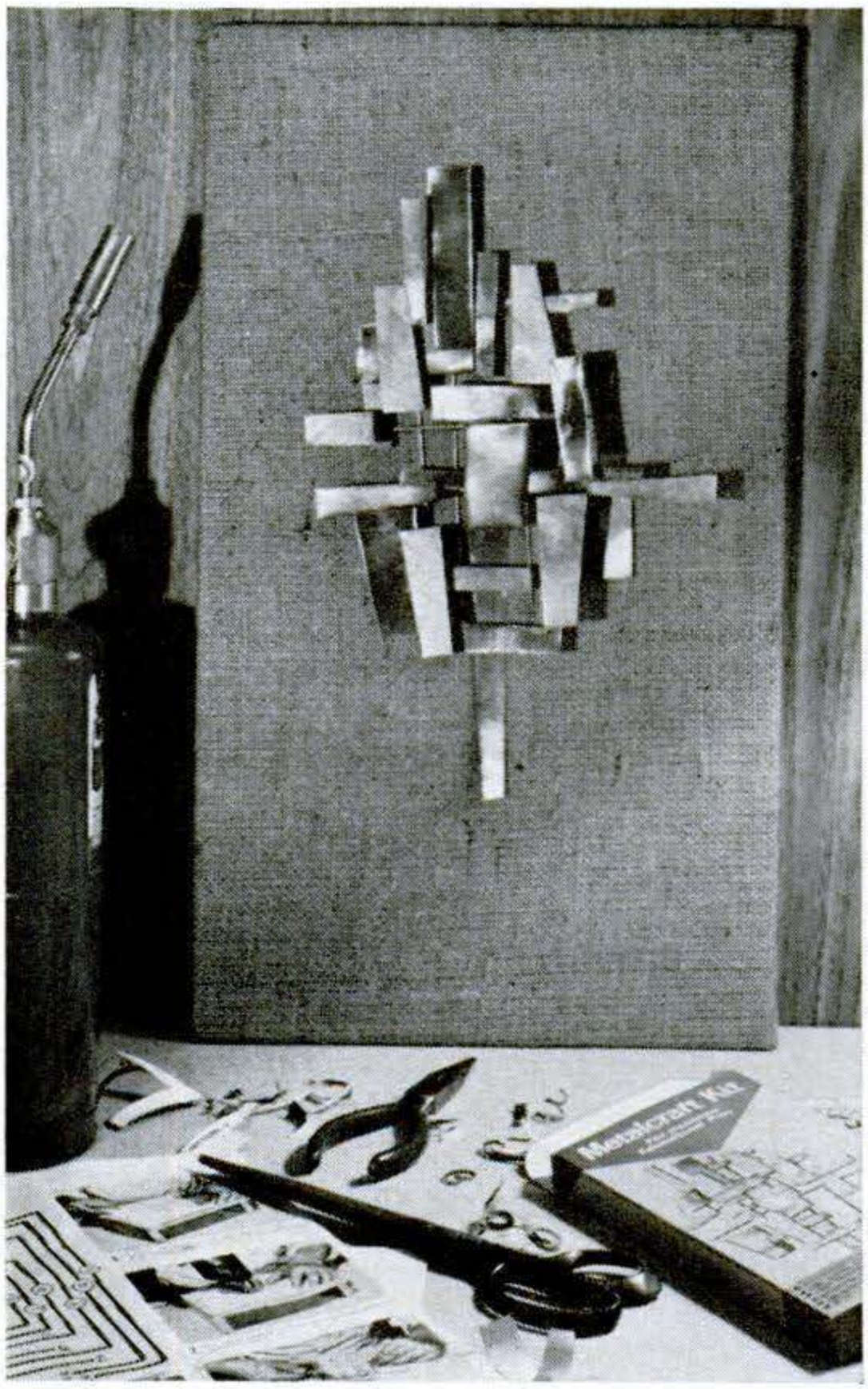


Kit contains everything for making wall sculpture of Soldersheet and copper—a good project for learning how to work with the new repair and craft material.

For repairs or craftwork, you cut this multipurpose sheet with scissors, anchor it with heat

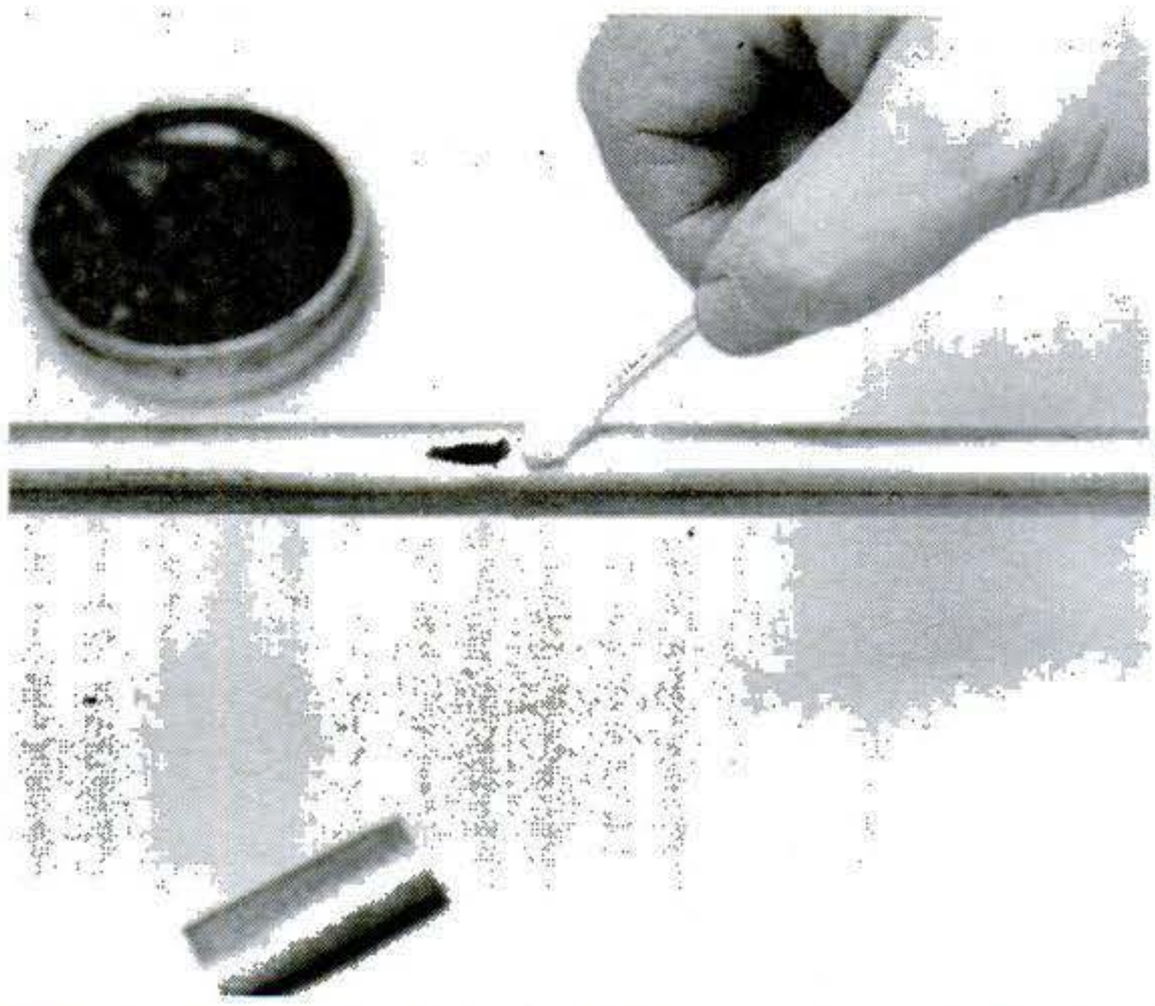
By RONALD M. BENREY

The stuff looks and feels like limp ga vanized iron; it's really a thin m of steel-wool-like sponge saturated wi solder. The steel fibers are bonded t gether before the voids are filled. T porous steel matting keeps the solder i side—even when molten—the way a bl ter sops up and retains ink.

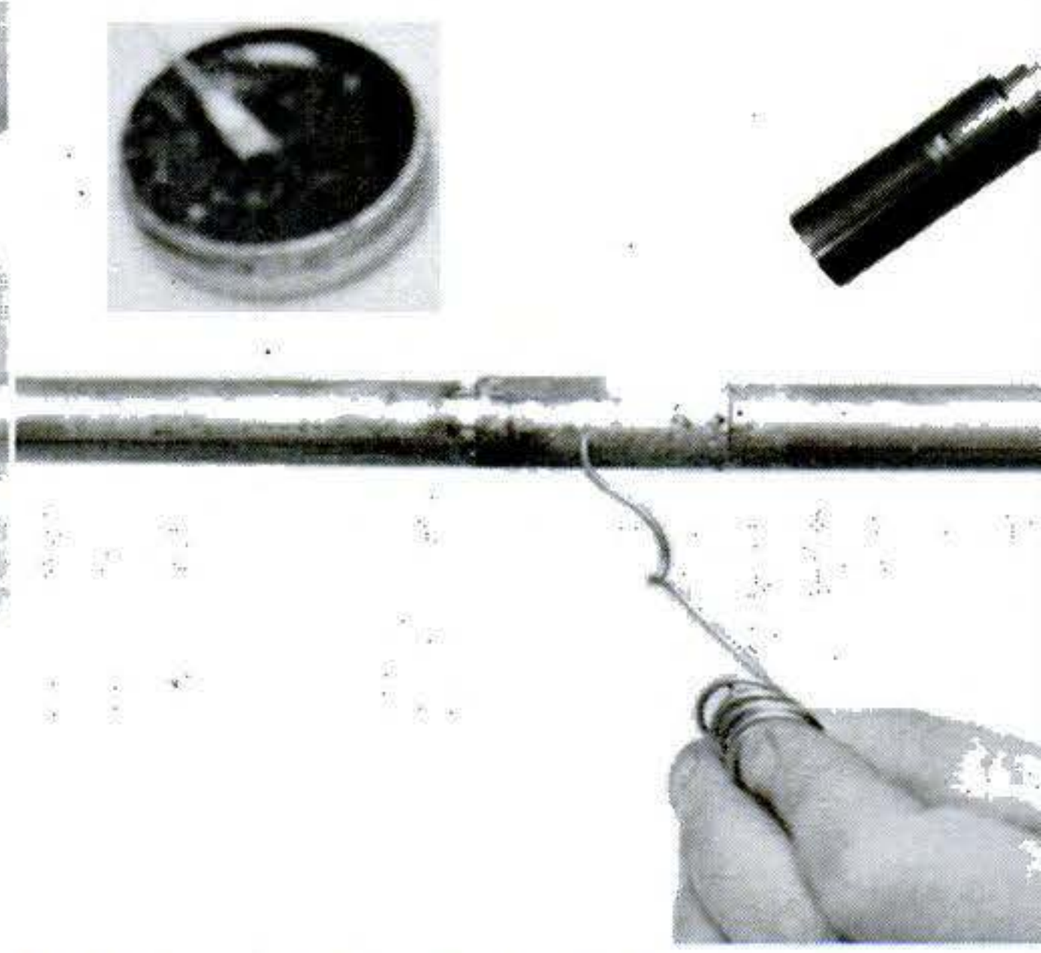
It's called Soldersheet Metal, but you gain a better picture of how it works you think of it as "steel-reinforced s der." As with reinforced concrete, t addition of the steel mat transforms t usually soft solder into a tough stru tural material.

I found several useful applications f the new material:

- To patch small holes in pipes, tank or gutters made of copper, steel, or a other solderable metal. The proce (demonstrated below) is similar to a plying an old-style "hot-patch" to a ru



Hole in tubing can be mended by cleaning and fluxing area for shaped sheet patch, shown below hole.



Patch is applied with heat. It's usually necessa to replenish molten solder with conventional supp

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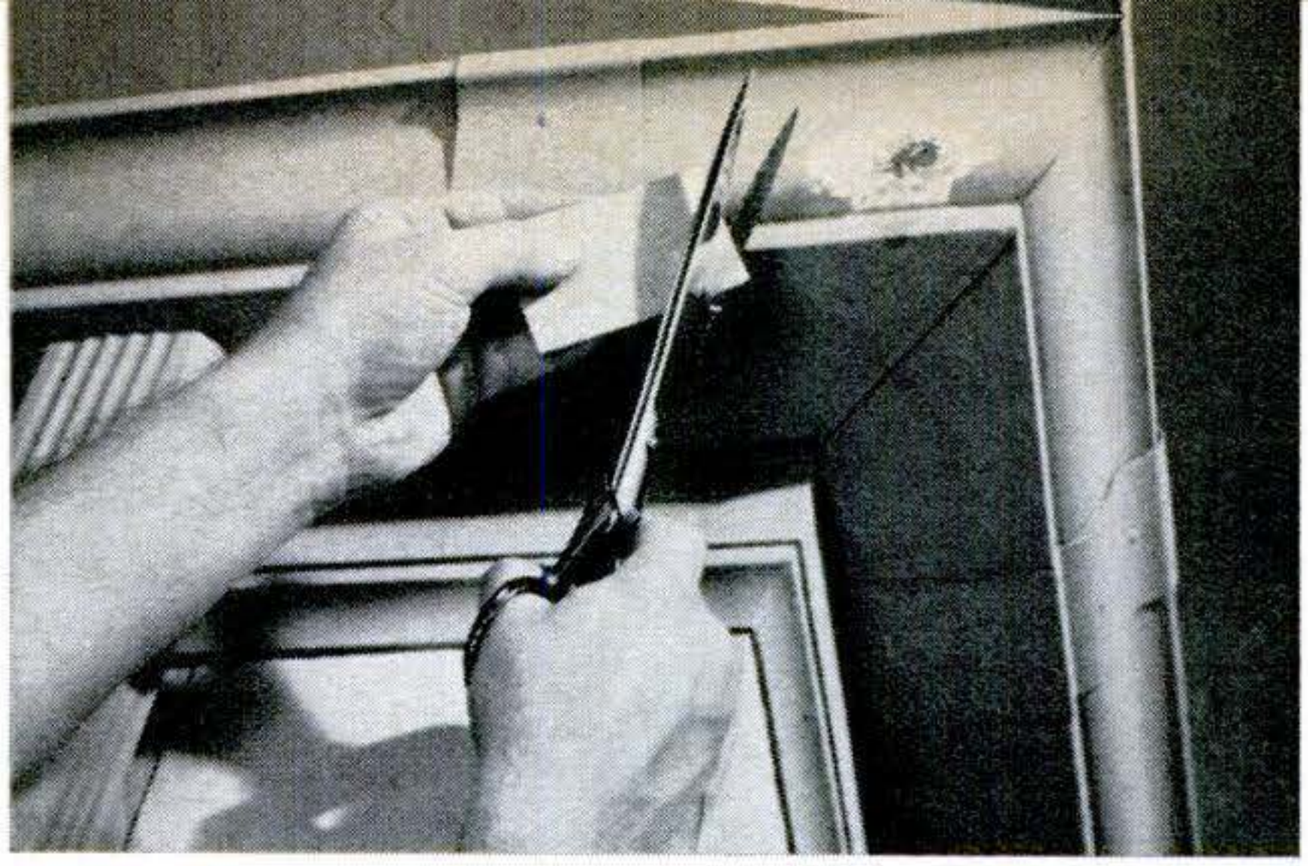
Blanket

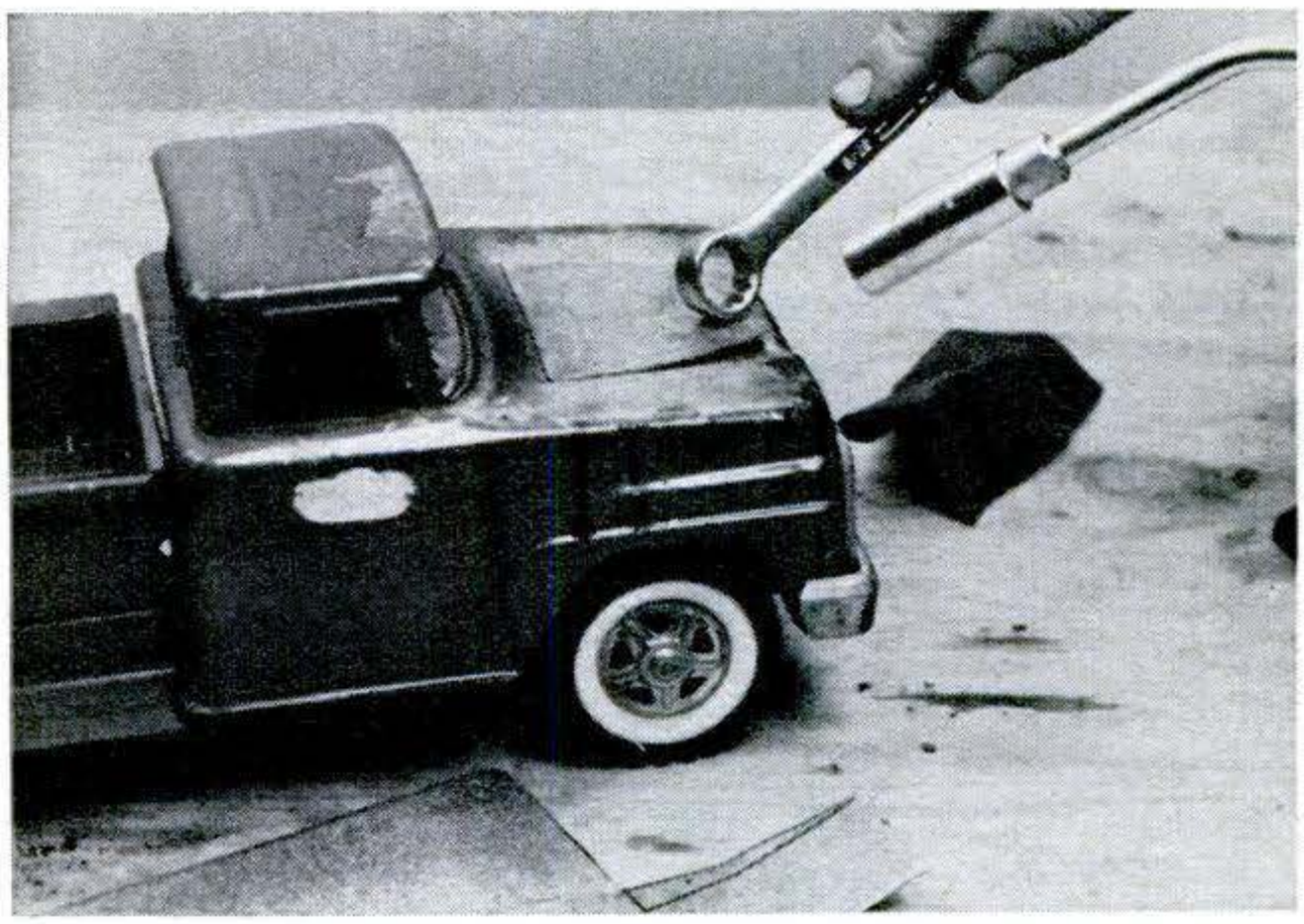
ber inner tube. The material is strong enough to seal up leaks n high-pressure plumbing lines, ranging from pinholes to punctures ¼-inch in diameter. (Don't use it to patch large splits or bursts, however—the relatively flexible metal will balloon outward.)

- As a "solder holder" for blind soldering, such as mounting handles, hinges, or decorative objects on flat metal surfaces. Here, the Soldersheet goes between the object and the surface (it helps if both are tinned with a thin film of conventional solder, first). You apply the iron or torch flame to several points on the object to spot-solder it in place.
- To solder overlapping seams together. The same trick used for blind soldering works here, if you will accept relatively thick seams—Soldersheet is roughly 1/32 inch thick. It's very easy to form wholly watertight seams by heating all along the seam length.
- As a purely decorative material. The dull silver color of Soldersheet contrasts nicely with copper, and the two metals can be used to create attractive sculptures. You can design your own, or buy a kit that includes directions and patterns to build the one shown here.
- For furniture projects. You can join strips of the stuff, shaped with finger pressure, into decorative scrolls.

For best results. All the surfaces involved (including the Soldersheet) must be clean and well fluxed. Although a soldering iron or gun will work, I found that the most satisfactory joints are made with a torch flame. The idea is to heat the entire piece of Soldersheet so that all of its solder melts at the same time. This causes every element of the joint to form simultaneously, and prevents the unwanted look of "cold-soldered" regions, which are also mechanically unsound.



Leaks in metal gutters are easily plugged. Just cut a solder patch to shape of area you have cleaned around the hole, flux both gutter and patch, clamp patch in place, and apply heat.



Another repair technique is to "iron on" a patch, fluxed on both sides. Using torch and a wrench, patch can be pressed in place. Wrench acts as chill, should be periodically cooled in water.

To prevent discoloring the heated surface of the Soldersheet, apply flux to the outer face as well as to the surface to be joined.

Also, repeatedly apply (and replenish) the surface solder film on any piece of Soldersheet that you have directly exposed to the flame (as when patching a pipe). This replaces the solder lost to the joint underneath, and helps displace the oxide film on the surface that interferes with proper heat transfer.

A kit containing an eight-by-four-inch piece of Soldersheet, a matching sheet of copper, copper rods, soldering flux, and detailed instructions for the sculpture can be obtained by sending $4 (which includes postage and handling) to Huyck Metals Co., Box 125, Parcel Post Station, Milford, Conn. 06460. National retail distribution is expected soon.

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The Living Cube 4x4, an example of Ken Isaacs' Matrix Projects

Ken Isaacs, author of this article and developer of the Matrix Idea, is seen above emerging from the access turret of his Living Cube 4x4, an experimental Microhouse he built at the Matrix Research Project, Groveland, Ill.

The Matrix Idea, the young designer says, means that "I strive in each case toward construction of a total *environment*—or matrix—that integrates all functions of the unit at hand."

The Living Cube 4x4 is one of his family of new designs. Intended for one person, it's a four-foot cube augmented by turrets that provide storage and a bed. It has a four-foot-by-six-foot outside deck and rests on pads that don't disturb the site. Mrs. Barbara Isaacs, cinematographer and film director, is seen in the lower opening.

POPULAR SCIENCE readers were introduced to Ken Isaacs' work last March when plans for his Superchair were published. The Superchair, an 8x8 Living Structure, and the Microdorm are being sold through the Abraham & Straus department store, in Brooklyn, N. Y.

Isaacs has now opened a retail center at 324 E. 73 St., NYC 10021, for distribution of his Matrix Idea products. He has designated this center Groveland 2.

"Groveland 2," he says, "will offer for sale Living Structures (and other products) designed by me. It will also serve as an informational point for the distribution of facts about Living Structures, Microhouses, and Matrix projects. Educational devices of my design will be sold at a later date."

How to Build the Microdorm

[*Continued from page 138*]

child to have his own *private* piece architecture rather than a hodgepodge traditional furniture, most of which w designed for adult use. We all will a preciate what a Living Structure c mean to a youngster by recalling t excitement we had at age eight or in playing in a large corrugated box

I think we learn to live best when c physical environment supports order a alertness, encouraging us toward stu understanding, and constructive acti If our surroundings are chaotic and bas on superficial notions about life valu our approach to life may end by bei haphazard and cynical. If there are shelves for books, few will read. If th is no privacy, few will think.

The Microdorm was also designed w consideration for the day-to-day pro lems of cleaning and maintenance. Fro the housekeeping point of view, it mak cleaner room spaces possible because is open and easy to clean. Heating a cooling are better because the grid allo free air circulation.

The structure requires so little flo space that it will work in an extreme small bedroom and still leave extra squa footage for activities. A slightly larg room will accommodate two children wi a central space remaining for car trac games, and other uses in common. T emotional pressures that may be gener ed in children by forced sharing—a fe ture of traditional furniture designs—w be relieved by the fact that now each h his own structure. There is none of t old-fashioned overlapping use of tabl chairs, and shelves—a source of confli

The Microdorm fulfills the living equ tion so comprehensively that it will wo just as well for the high-school stude as the eight-year-old. Actually, as stu and work requirements increase with m turity, the basic features acquire increa ing importance. It is usable througho a youngster's school years.

Building the Microdorm. Select the d est, straightest Douglas fir (or white fi two-by-twos in the lumberyard. Followi the cutting schedule, mark lengths c top and two sides of the two-by-two wi a square. Saw slightly beyond these line then use them as a guide for rasping t

Continu

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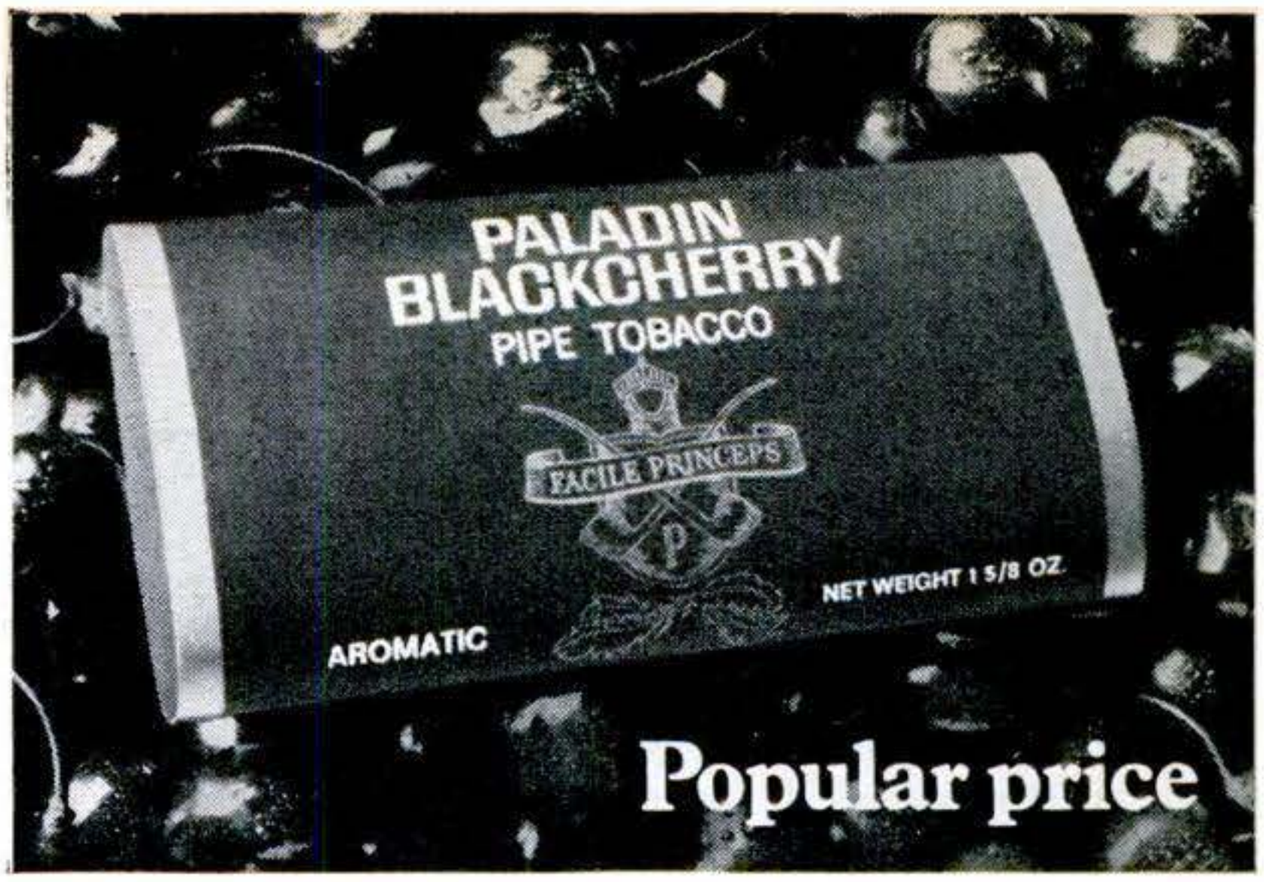

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ends as smooth and square as you can.

Study the drawing before beginning hole layout. Holes are made with a 5/16" drill. The counterbores are 5/8" deep and can be made with a 7/8" spade bit. All holes are on the longitudinal centerline of the two-by-two.

Assemble the two longitudinal (side) frames first. Then add the 3' crossmembers and the two table supports. Secure the two extra crossmember bed-panel supports last—18" on either side of the center posts.

Cutting and drilling the panels. Cut the bed and seat panels from 1/4" hardboard. The three bookshelves can be cut from scraps of hardboard. Cut 3/4" off each corner at a 45-degree angle to prevent snagging. Lay out holes and drill with a 1/4" bit and countersink for flathead machine screws. The headboard and table are cut from 3/4" plywood.

Note that the guard-rail holes in the headboard are drilled 9/16" diameter (oversize) to ease fitting problems. The two 3/8" holes for the light arms (in headboard edge, top and bottom) are a little ticklish, so take time and sight well. The headboard is secured to the frame with two 2 1/2" and two 4" hex-head machine screws. Put four washers on each.

Assembling the drawers. Cut the drawer sides from 3/4" fir plywood. Drawer bottoms can be 1/4" hardboard. If you plan to store equipment or heavy items in addition to clothing, better use 3/8" plywood. There is plenty of clearance for the added thickness. It is easier to sand, drill, and countersink holes in the sides before assembly. Use a stapling gun in the plywood edges to hold the pieces together before nailing and gluing. This makes nailing easier and the fit will be more precise. Be sure of good glue coverage, with a 1" brad every 4" to keep the bottom from pulling loose.

Last step is to bolt two-by-two slides to the drawer, using 2" flathead machine screws with heads countersunk *inside* the drawer. The drawer retainers are bent in a vise from aluminum strip, drilled with a 1/4" bit, and sandwiched between drawer and slide on the rear bolt. Use two washers on the front bolt to equalize the thickness. The bottom, or horizontal, leg of the retainer bears against the underside of the drawer support, and prevents the drawer from tipping when it is pulled out past its balance point. As a further safety measure (to prevent the drawer from being pulled all the way out and falling), screw a 1/2"-high rubber bumper on the bottom side of each of the eight drawer-support members near the drawer-face end.

The guard rails are bent of 1/2" aluminum rod, using a vise and a scrap of water pipe slipped over one end as a lever. Bend the two light arms of 3/8" aluminum rod at the same time. File the cut ends flat and clean before inserting in holes or attaching socket clamps.

Tension cables. Two tension cables (with turnbuckles) anchored at the centers of the longitudinal frame members (see photo) counteract stresses caused by using the drawer supports as a ladder to reach the bed. To install, replace the appropriate 2 1/2" bolts with eyebolts. Open the bottom eyebolts to take turnbuckle eyes. Secure all cable end-loops with electrical connectors.

The electric outlet is a standard steel box with four receptacles. Bolt it to the underside of the bed panel with 3/4" flathead machine screws. It services the table lamp and the reading lamp on the headboard. In addition it offers two extra plug-ins for typewriter, soldering gun, etc. The supply cord is threaded through a 3/8" hole in the middle crossmember and another in the short transverse bed-panel support. It is guided to the floor by two eyebolts inserted in place of two of the frame bolts in the vertical member at the end of the bookshelves. The lamp sockets will take 50- or 75-watt reflector flood bulbs, which need no shades and give high-intensity light.

Finishing up. To eliminate splinters, round the long corners of all two-by-twos with a plane and rasp. Sand all surfaces smooth with fine aluminum-oxide paper. Apply three coats of a deep-penetrating clear resin sealer (Firzite), sanding between coats. Finish with fine steel wool, paste wax, and rub with a soft cloth.

Sand all hardboard panels and edges smooth. Then roller-coat with a flat paint. The drawers can also be roller-coated, but leave the two-by-two slides natural. Wax to decrease friction. PS

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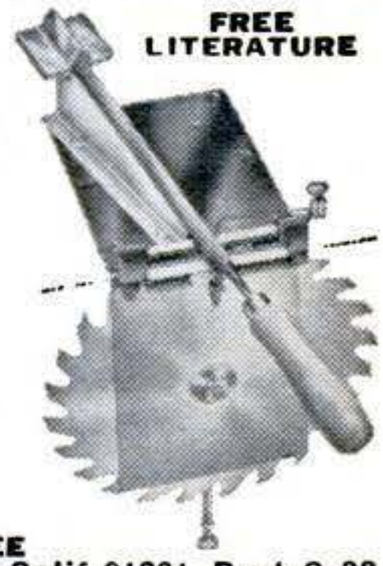

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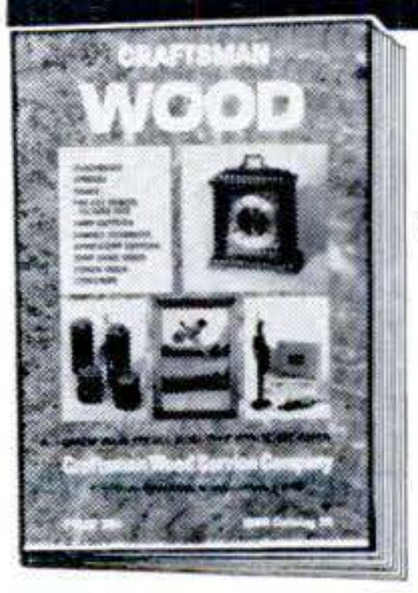

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What Apollo 8 Moon Flight Did for Us

[Continued from page 71]

discarded stage, by dumping its residual propellants, was to propel itself past the moon's trailing edge and on into a permanent solar orbit. Spewing fumes, it hung a few hundred feet away, looking like a "furious white elephant" to Borman and pointing too close for comfort. He fired up the small spacecraft thrusters to get out of its way. (The first two spent stages, never in orbit, had fallen in the Atlantic.)

In the spacecraft, coasting now on a 66-hour journey to the moon, the crew doffed their pressure suits—and enjoyed the comfort of simple lightweight coveralls for the rest of their trip.

Behind, the world shrank. "I can see the entire earth now out of the center window," Borman reported from 30,000-mile distance. The crew made a slight midcourse correction, with the 20,500-pound-thrust Service Module engine.

As if going upgrade, the coasting craft was slowed by the earth's tug to about 2,200 m.p.h. before reaching the point, 38,900 miles from the moon, where lunar gravity took over. Then the moon's gravity, pulling the craft "downhill," speeded it up again to more than 5,700 m.p.h. A final midcourse correction was made with the craft's small thrusters (miniature rocket engines).

The moon itself, in its orbit around the earth, was sweeping along at 2,287 m.p.h. Past its leading edge scooted Apollo 8 like a car beating a locomotive to a railroad crossing. But the Apollo could not see the moon's rapidly growing bulk during this encounter, because its leading edge was not lit by the sun. "It was like a GCA [ground-control approach] with a 200-foot ceiling," Borman commented later. "All a pilot can do is have faith in his ground controller."

The most fateful decision. Nearly an hour before, it had been decided to commit the spacecraft to a lunar orbit.

Until then, the crew were assured of returning automatically to earth. If they lifted not a finger, the moon's gravity would swing them around it and head them homeward. But this "free return" had to be relinquished if lunar-orbiting power maneuvers were to be rehearsed.

Apollo 8 swung behind the moon, and out of radio contact with earth. The craft

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urned hind end forward, and its engine ired for more than four minutes, braking ts speed to about 3,600 m.p.h. It was in unar orbit—initially an elliptical one, rom about 70 to 195 statute miles above he moon. As the astronauts began their hird circuit, they fired the engine again or 9½ seconds, making their orbit circu-ar at 70-mile height.

What the astronauts saw. Ten times the raft circled the moon, each circuit tak-ng two hours. For the astronauts, those 0 hours were busy indeed.

A prospective Apollo lunar-landing site n the Sea of Tranquility, and landmarks or approaching it, drew their special at-ention. You couldn't miss it, they re-orted. Easily they spotted a certain tri-ngular mountain and other promising uides seen before only on photographs rom unmanned spacecraft.

They took still photos and movies of heir own—which, because these could be rought back, excelled in quality even he magnificent moon pictures televised y our Lunar Orbiters. They examined lozens of "targets" of special interest—nd shared with stay-at-homes their view f the moon's scenery, in two of the voy-ge's six telecasts.

As they talked with Houston, voices ame loud and clear across nearly a quar-er-million miles—a distance that radio vaves took 1¼ seconds to span, as gaps etween messages showed. Performance f the two-way communication hookup, ital for transmitting data and instruc-ions, surpassed even its engineers' hopes.

Then came what was probably the most ritical maneuver of all. On the moon's ar side, the crew fired up the spacecraft ngine to break free from lunar gravity. Had it failed, they would have been opelessly marooned in lunar orbit. But ts perfect burn, of more than three min-tes, boosted their speed past the moon's ,328-m.p.h. escape velocity—and they vere homeward bound.

Coming back. Only one midcourse cor-ection, with the small thrusters, was eeded on the 58-hour coast back to arth—which was comparatively unevent-ul until its final moments.

As Apollo 8 neared earth its speed eached about 24,700 m.p.h. Jettisoning

Continued

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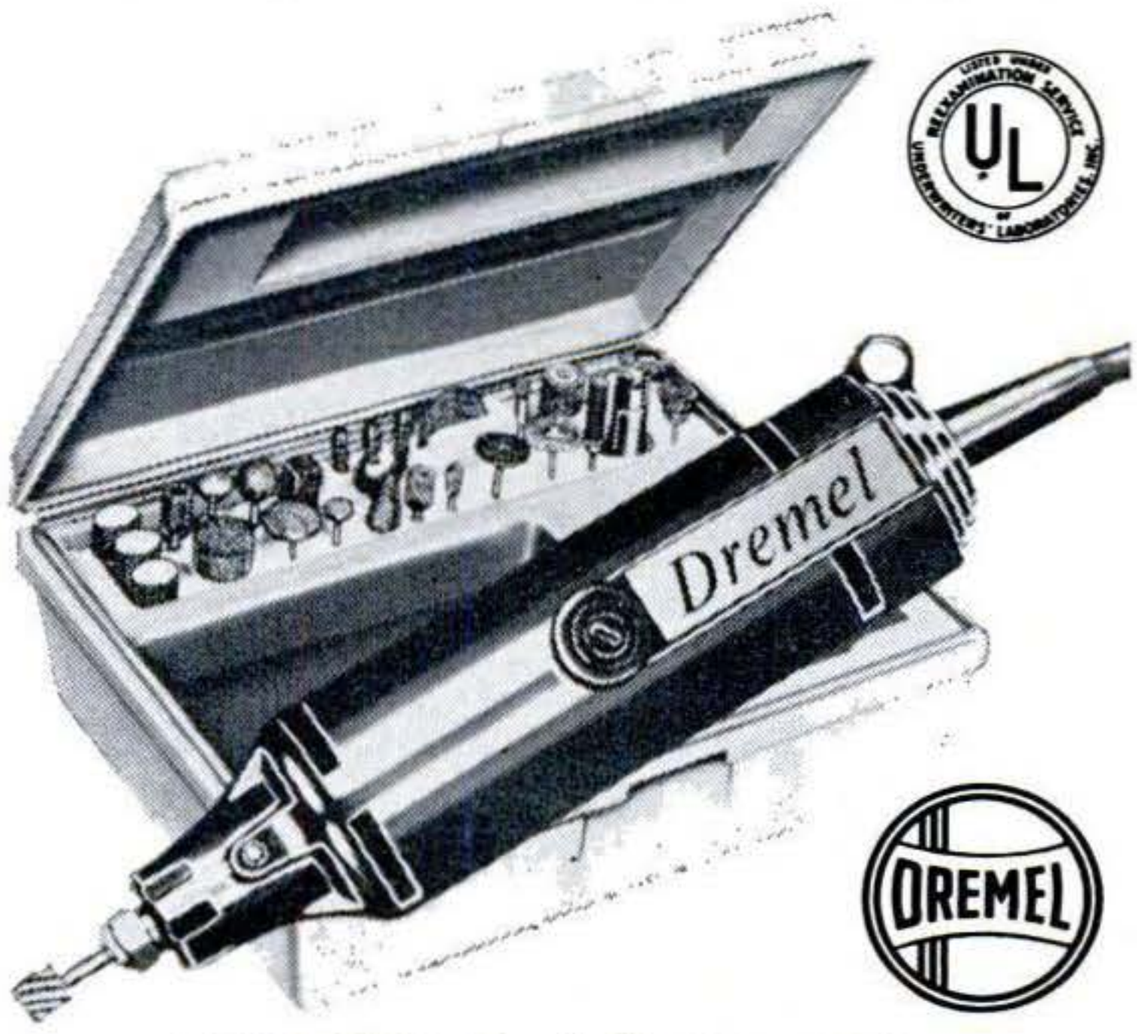

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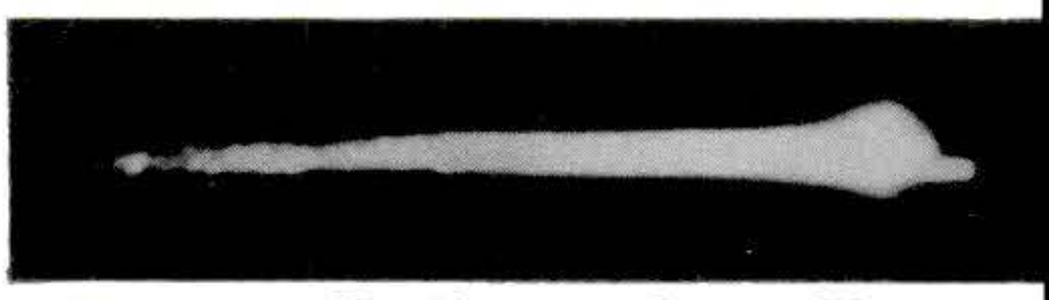
What Apollo 8 Moon Flight Did for Us

the Service Module to fiery distructio the manned Command Module plunge into the atmosphere at a shallow slan Instead of a dual-pulse "skip" entr planned earlier, it had been decided to se the spacecraft's automatic re-entry-guid ance system for one continuous descent steadily downward, except for two min rises along the way.

(The Apollo Command Module trimmed in such a fashion that it seeks a angle of attack of approximately 30 de grees. This creates a lift force at righ angles to the drag force. During the in tial phase of reentry the lift force acte upward, gradually leveling off the de scent. When the spacecraft began to ris again, its autopilot—acting on tangentia control thrusters—rotated it 180 degree so that the lift force acted downward.)

This descent strategy would keep th heat shield's temperature within an ac ceptable figure, nearly 5,000 degrees. Th cabin temperature, a comfortable 77 to 7 degrees throughout the voyage, was pu posely lowered to 61 degrees.

A tracking plane at 40,000 feet caugh the spectacular photo below of Apollo 8 flaming reentry.



Then Apollo 8's parachutes blossome out, one hour before dawn, and the cre readied itself for a "gentle plop" into th water like Apollo 7's. But it seemed tha the waves of the Pacific Ocean had faile to take instructions from Mission Contro Apollo 8 hit the water as if it were strikin a brick wall.

The crew was doused by half a gallo of salt water entering through the ven stack, and for an instant it looked as i their return from the moon would be ter minated at the bottom of the sea. Th spacecraft capsized and had to be righte by the righting bags. But the crew ha come down to a pinpoint landing withi some 5,000 yards of the recovery carrie Yorktown, and soon the carrier had as tronauts and spacecraft safely aboard.

Apollo 8, mission accomplished, ha taken man on his first historic voyage t another world.

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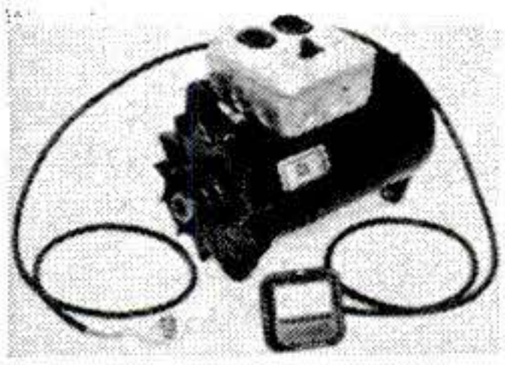

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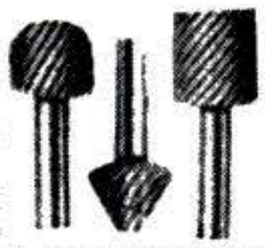

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Shelf System for a Show-Off Wall

[Continued from page 158]

base blocks—even in a room with an 8′ ceiling.

I chose an overall depth of 11⅞″ so I could get four compartment sides from a standard 4′-by-8′ sheet of plywood. This is ample depth for large books and objects, while smaller books can be pushed to the rear of the shelves to make room for small objects in front.

These units can also serve as a room divider, either in a single row, adequately braced to the end wall and ceiling, or in a back-to-back arrangement.

Once you decide on the position of your shelves within a unit, install the aluminum support strips on the inside faces.

Shelf-support strips. These were cut from stock aluminum T. (The front trim strips are the same material, with the face and visible edges polished to a mirror finish.)

Fasten the support strips with screws driven into a pair of kerfs cut the full length of each upright before the units are assembled. These kerfs will conceal screw holes should the shelves later be relocated. (The opposite face of each upright has a groove for the joint spline or filler strip.)

To start, install only one support strip for each shelf (clapping a square against the front edge of the upright to make sure the bracket will be level). Slide one kerfed end of the shelf onto this strip, and place a level near the front edge of the shelf; adjust the shelf's free end until it is level. Then scribe a line on that upright to indicate the position of the second support.

Other components besides shelves—drawers, storage compartments with sliding or hinged doors, speaker enclosures—can be installed without support strips. Drive screws from the inside of such units into the kerfs in the uprights.

For special effects, removable color-accent panels can be inserted between shelves as display backgrounds. These panels can be prefinished or painted hardboard, or heavy cardboard covered with fabric or wallpaper.

Because of the variety of color in the objects I wished to display, I finished my unit flat white—including the hardboard backs and the ¾″ plywood shelves. PS

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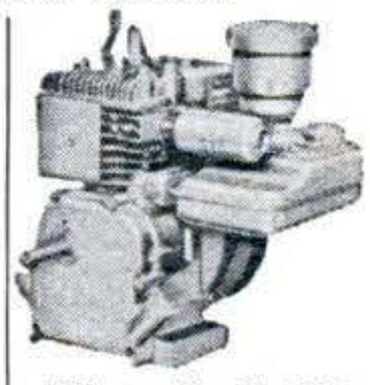

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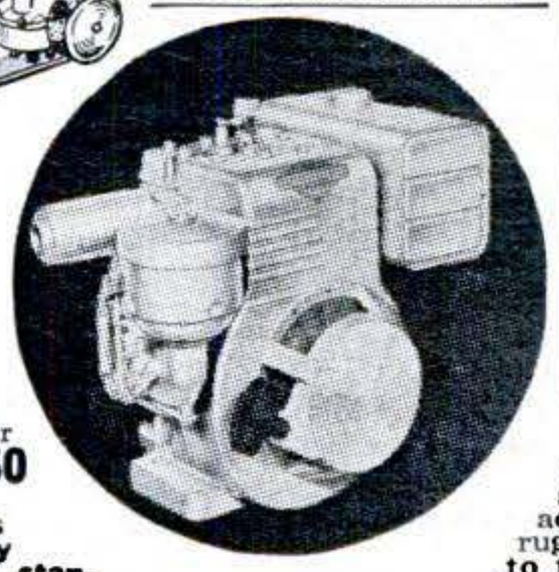

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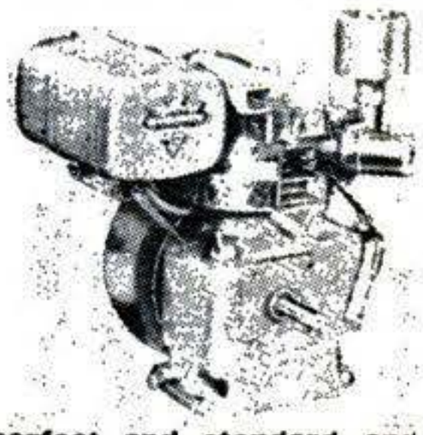

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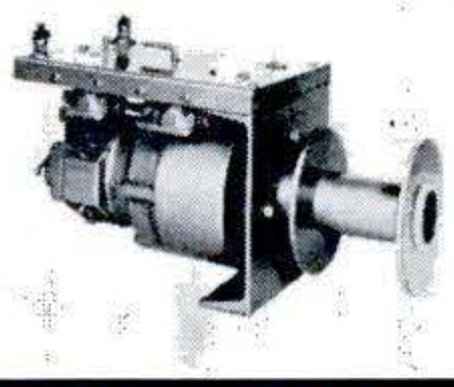

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Window-Shopping in Russia

[*Continued from page 83*]

ties for the typical Soviet apartment may cost only $12-$15 a month, and all medical care is free. Thus a larger percentage of income can go for food, clothes, and other necessities, or even luxuries. A further fact is that almost everyone works—Mama, Grandma, even the kids: At harvest time, school may close down for a month and adjourn to the farm so pupils can pick tomatoes or grapes.

In some ways, Ivan spends his money much like his U.S. counterpart: He pays income taxes; he pays fare for the bus, trolley, or subway that takes him to work (four or five kopeks; there are 100 kopeks to a ruble); he takes the kids to the circus (which is great; every major city has its own); he buys ice cream from a street vendor (a state employee, like virtually everyone, but the ice cream is first class); or he may buy the kids a glass of kvass, the national soft drink, which I found undrinkable. He can put some of his money in a savings account, too, but he can't write a check—there are no checking accounts.

But here are some impressions I came away with in comparing life in the Soviet Union with life in the U.S.:

- The overall quality of goods available is very poor, the prices very high. A man's suit of barely tolerable quality may run to more than 150 rubles, a shirt to more than 10 rubles.
- There is a pervasive impression of low standards of workmanship and inferior materials in much of the new building construction: splintery floors, cracked tiles, chipped stucco, open joints. Some of the poor work was amateurish, some clearly by don't-care workers.
- The design level of much of what you see, from toys to architecture, appears to be crude and/or imitative.
- Shopping is a wearisome, time-consuming chore. To make a typical purchase, Ivan selects his item, then pays a cashier for it, then presents the cashier's check to the original clerk to get the item. In each case, he most likely stands in line.
- Delivery time for some items is long, even when Ivan does have the money. I heard estimates of from three to five years for a car, a year or more for a TV

set or refrigerator. But car-delivery time should be shorter soon: Both Renault and Fiat are building auto factories in the USSR, on contract with the government. I was told that these would be in production by 1972.

• Outside of automobiles, the transportation system runs very well. Planes, trains, subways, trolleys, and buses are well maintained, comfortable, and numerous. I rode on the subways in Moscow, Leningrad, and Kiev: All are magnificently—perhaps palatially would be a better word—designed, with smooth-running, quiet trains and the longest escalators I have ever seen, running down perhaps 300 feet into the earth. One cavil at the transportation: Cabin pressurization in two of the five Aeroflot planes I traveled on was badly handled in coming down, resulting in painful earaches.

• An extraordinary feature of the Soviet retailing system is the existence of "foreign-exchange" stores. These accept only foreign currency or special "certificates," issued to certain privileged Soviet citizens. Prices frequently are a third or a quarter of those charged in regular Soviet stores. Thus foreigners can, at reasonable cost, bring home souvenirs; the government can pick up some badly needed foreign exchange—and a Soviet elite has access to super-discount stores.

• The contrasts are extraordinary. Looking out through the window of your turbojet airplane, you see hundreds of rivet heads poking out from the wing—a suggestion of a primitive assembly system in an otherwise sophisticated plane. In all the places where you see business done—your hotel, the stores, restaurants, agencies of one kind or another—you do not see a stapling machine, or a paper clip, or a roll of cellophane tape. Coming from a space exhibit to your new hotel, you ride to your floor in an elevator whose control system would have been obsolete in the U.S. 40 years ago. The plumbing in your hotel bathroom is crude and badly installed, and works inefficiently or maybe not at all—but the sink has a plastic trap.

Maybe it all goes to show that when a society must choose between smooth-working bathrooms and putting a man on the moon, the bathrooms may suffer. PS

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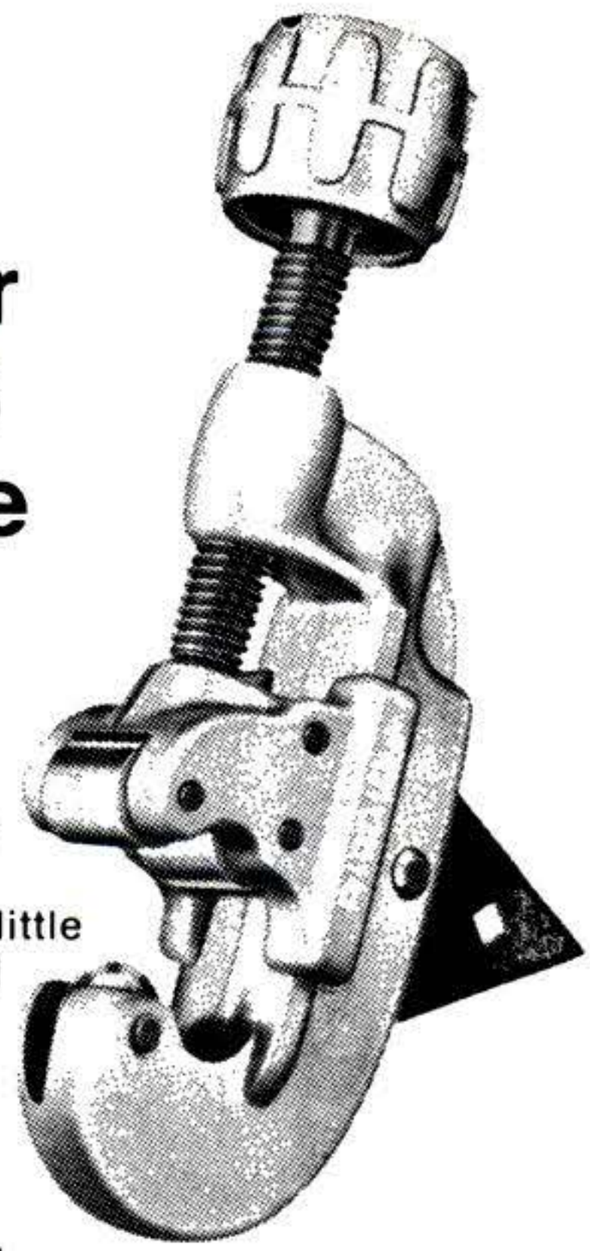

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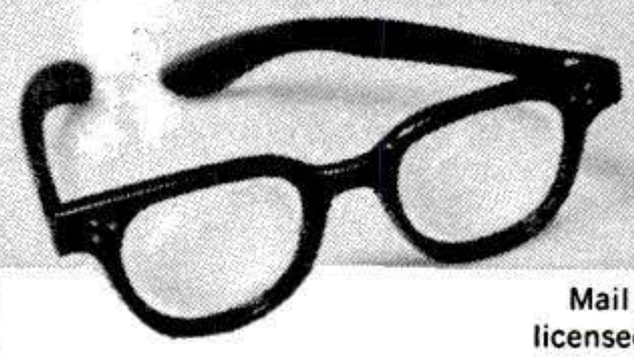

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Learn to Fly Without Leaving the Ground

[*Continued from page 95*]

One reason is that it is difficult to isolate a specific maneuver so that the student can practice it again and again without interruption. Before you can practice making a landing approach, for example, you must taxi to a runway, wait your turn to take off, take off and climb, and circle the airport to get back into the approach position. In the same time, you can make several complete simulator "takeoffs" and "landings."

Another reason is the dual job of the flight instructor: Besides teaching, he must always be in command of a real aircraft. Thus, if the student should maneuver the plane into a dangerous situation, the instructor must take control and fly the plane out of trouble—before he can begin to explain the mistake.

Like a fly on a pin. The simulator, by contrast, can be frozen in any attitude by simply flipping a set of switches. The instructor can immediately explain what the student did wrong, show him how to correct the error *himself*, and repeat the maneuver with safety.

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Actually, a computer that pretends it's flying—that's the GAT-1. PS

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What Can Go Wrong with "Glass" Hulls?

[*Continued from page 105*]

Although it's impossible to give a boat a complete going over in a showroom, there are a few checks you can make. Tropical Testers first goes over every boat with a rubber mallet. You can give a boat a quick "thump test" with a coin. The sides of the hull are not under too great stress, so they can sound a bit hollow. But the bottom should be solid.

Another easy test is to force one knee against parts of the hull, searching for spongy areas and hard spots. Stiffness—and the right distribution of stiffness—is the key to strength in fiberglass hulls. Some areas will be slightly flexible, but the change from flexible to stiff areas should be gradual, not sharp. Also, fiberglass is translucent, so if the light is strong enough you can look for it passing through. Blotches may indicate hard spots or delaminations. Of course you won't be able to check all areas of the hull this way.

Check structural details. Look for reinforcement at all stress points—cleats, chain plates, joints between hull sections and between stiffeners and hull (see drawing). Where extra thicknesses of glass fabric are used, they should taper to the boat's skin to prevent a hard spot from forming there.

All glass boats will deteriorate in time. For example, fiberglass loses a small amount of its strength in its first year's exposure to water, weather, gasoline, and so on. This "wet-strength" factor is allowed for in quality boats, and after the first year, strength remains nearly constant. Also, the glossy gel covering the boat is subject to color fading and cracking, or crazing—a network of tiny cracks.

Fading due to sunlight takes place over three to five years. Darker colors fade first, with lighter pigments and white standing up better. Cracking and crazing are less predictable, but may occur in as little as a year or two. This doesn't always indicate structural weakness, since the gel is more brittle than the resin in the fiberglass.

You should approach buying a fiberglass boat as you would a car. Quality varies considerably, so to get the best buy, there's no substitute for good judgment and good advice. PS

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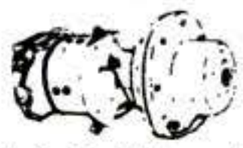

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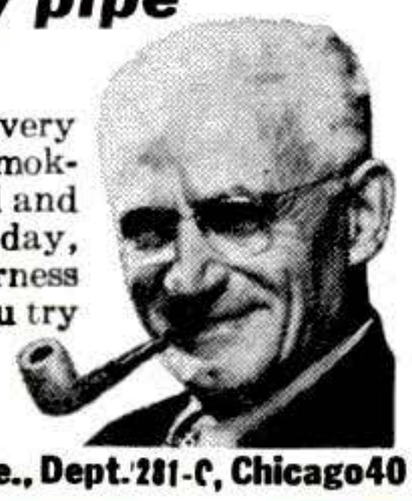

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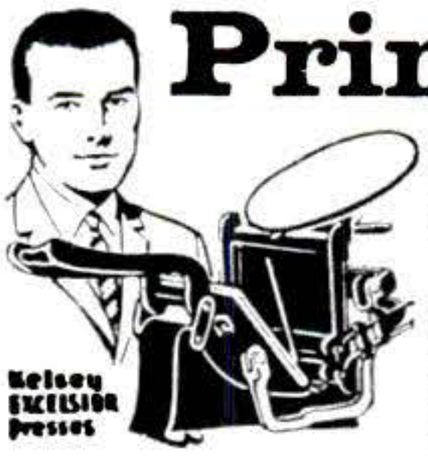

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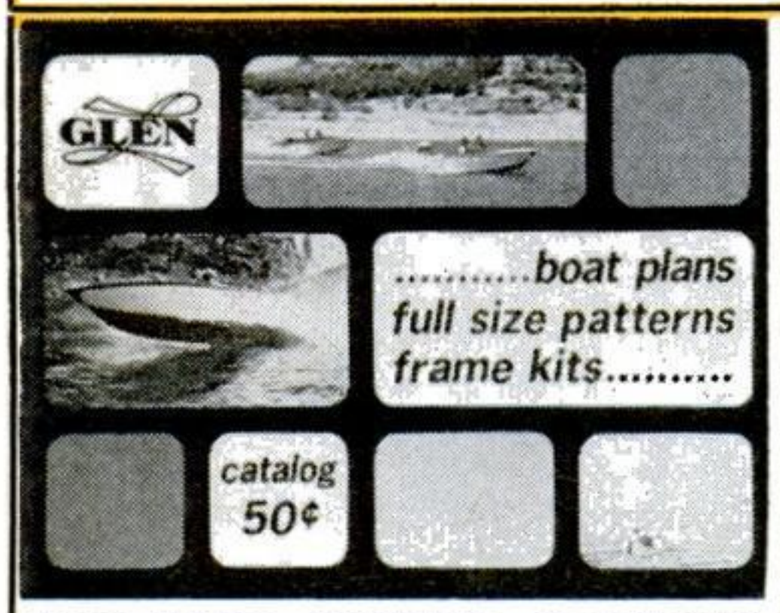

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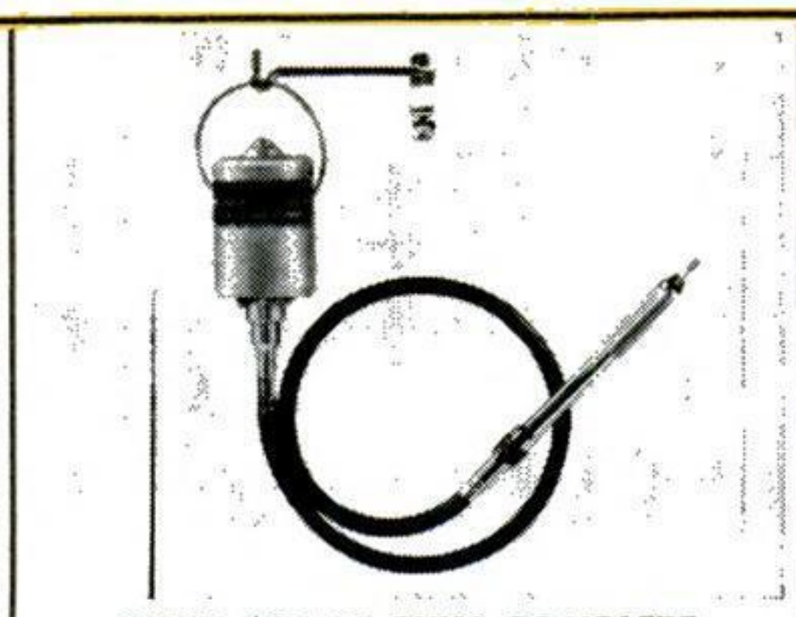

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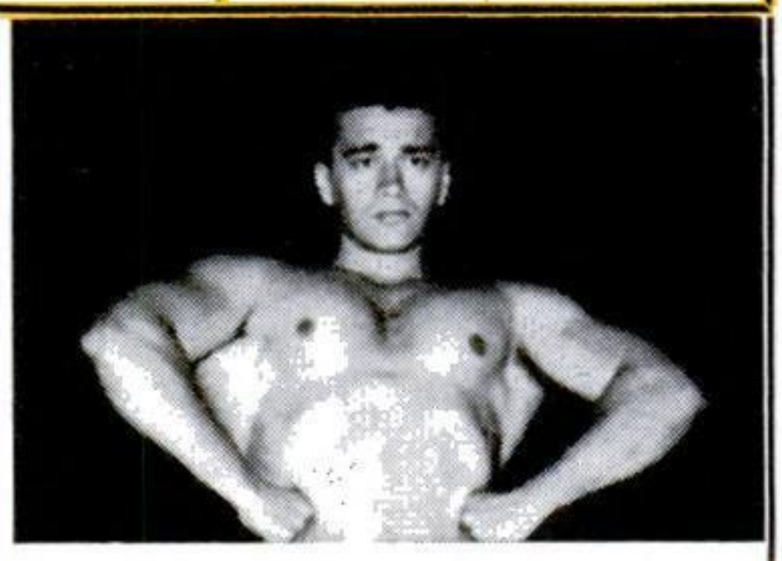

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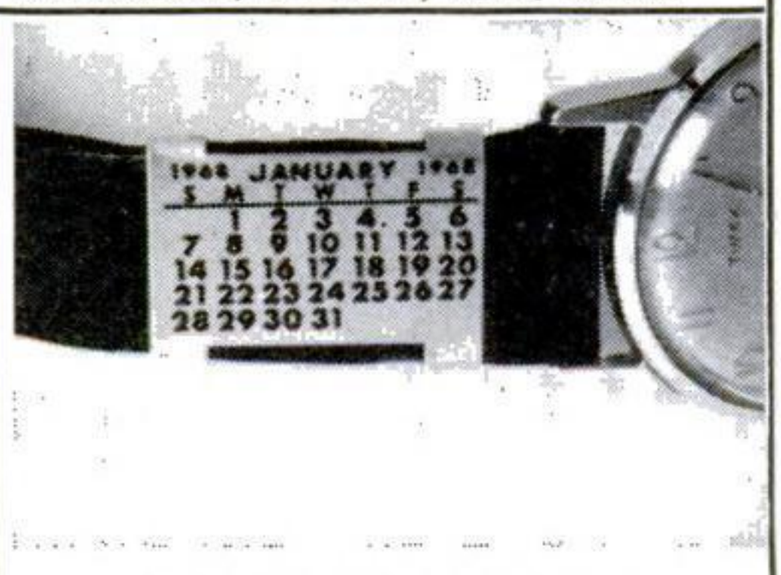

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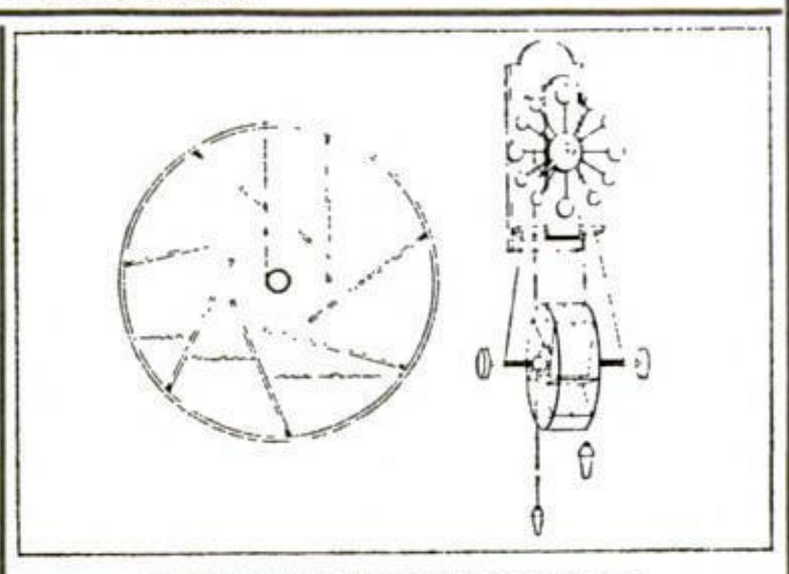

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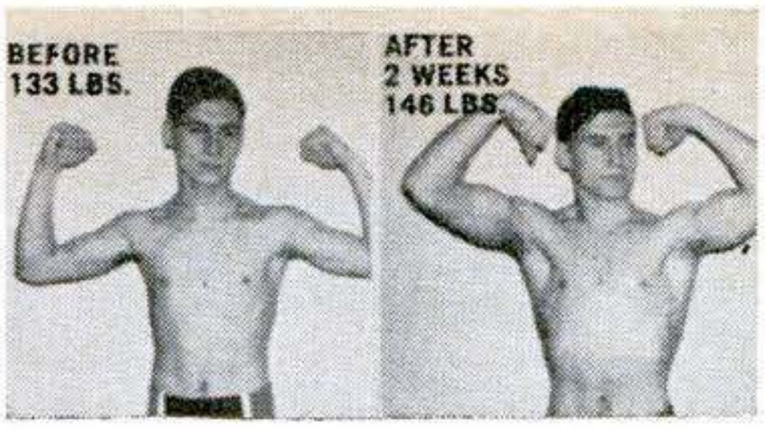

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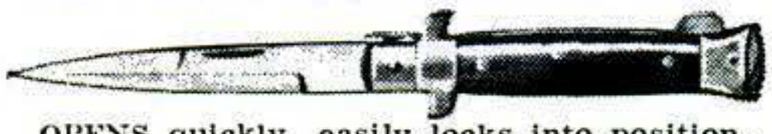

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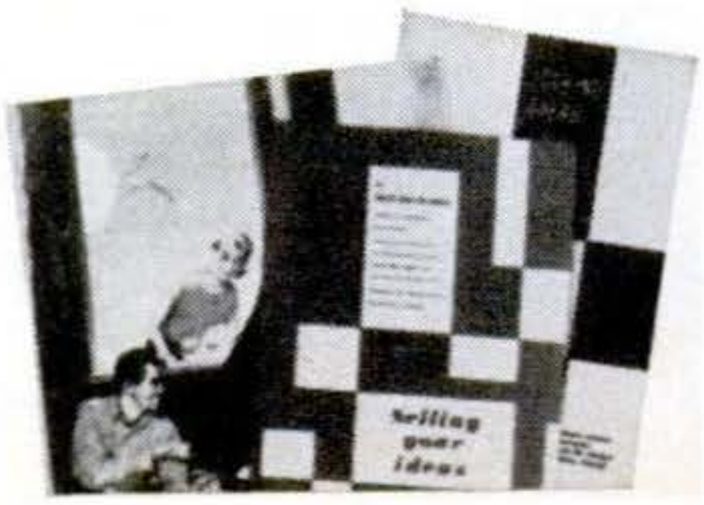

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